

INCORPORATION OF EARLY-MATURING SOYBEANS INTO A
REPRESENTATIVE SOUTHEASTERN KANSAS CROP FARM:
AN ECONOMIC ANALYSIS USING TARGET MOTAD

by

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CHAPTER I

INTRODUCTION

This study investigates the economic consequences of incorporating early-maturing soybeans (EMS) into a crop farm in southeastern Kansas. Early-maturing soybeans are those that are most generally grown in the northern United States. Response to day length determines when different soybean cultivars flower, leading to different dates of maturity. Soybean cultivars are classified into maturity groups which are identified by Roman numerals, ranging from 00 to X, with 00 cultivars maturing earliest and X maturing latest (Hartwig). Figures 1.1 and 1.2 illustrate the geographic regions of soybean cultivar adaptation and growing season by maturity group, respectively.

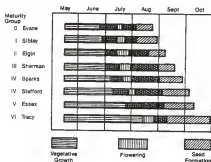
The most common soybean cultivars grown in southeastern Kansas are from groups III through V, with group V being dominant. In this thesis, groups III through V are referred to as traditional soybeans (TS) and are normally planted in June and harvested in October. EMS that are grown in southeastern Kansas are members of groups 00, 0 and I. In southeastern Kansas EMS are planted in April and harvested in late July or early August. These cultivars and their related production systems and resource requirements represent a possible diversification strategy from traditional soybeans. Since the timing of EMS differs from

Figure 1.1 Approximate Growing Areas of Soybean Maturity Groups.



Source of figure and quotation is Soybean Production Handbook. C-440 revised, Oct. 1987. Cooperative Extension Service, Kansas State University.

Figure 1.2. Soybean Variety Growth Patterns.



Source of figure is Soybean Production Handbook. C-449 revised, Oct. 1987. Cooperative Extension Service, Kansas State University.

that of TS, incorporation of EMS on a representative crop farm has implications for income, risk, labor usage, machinery size, field work hours, cash flow, and management time.

Interest of farmers and preliminary research results obtained by Kansas Agricultural Experiment Station scientists suggest that EMS might be a viable option in southeast Kansas. Early-maturing soybeans are being produced by a few southeastern Kansas farmers (Thornton). Babaoğlu, in his master's thesis investigated the agronomic potential for EMS in eastern Kansas. He concluded that EMS may have agronomic potential in years when spring and early summer receive normal rainfall and mid summer to fall is dry. In response to farmer interest and encouragement research investigating agronomic potential of early-maturing soybeans at the Southeast Kansas Branch Experiment Station was initiated in 1986 (Granade 1987). Because of favorable results, the agronomic research was redesigned for a five-year study starting in 1987, to further investigate the agronomic potential of early-maturing soybean cultivars versus traditional soybean cultivars (Granade 1988, 1989).

Agronomic research at the Southeast Kansas Branch Experiment Station, Parsons, Kansas, provides data for this economic study. But because only two years of EMS data are available from the on-going experiment, crop simulation models are used to provide a longer series of soybean

yields. Farm management records from the Southeast Kansas Farm Management Association serve as a primary source of data for specification of a crop farm representative of southeastern Kansas.

The Problem and Justification

Continuing interest in the mid to late 1980's has focused on the improvement of profitability, survival, and cash flows of crop farms. Reduction of risk to farm operators through diversification has also been a focus of research and teaching (Boehlje and Eidman). Diversification of operations, addition of alternative enterprises to existing farms, reduction of field operations by means of reduced tillage to reduce cash costs; all may enhance cash flow and profitability to assure continuation of the farm. This study investigates diversification into EMS as an additional enterprise or activity for crop farms.

Soybeans have gained in importance in southeastern Kansas as well as the rest of the state. In 1987, the value of the Kansas soybean crop was estimated to be \$358 million, a 33 percent increase over the previous year. A record 2.1 million acres of soybeans were harvested in Kansas in 1987. This was the first time that the soybean crop value substantially surpassed the value of the corn crop (Kansas Agricultural Statistics 1988a). Table 1.1 shows the 1968-87 annual acres harvested and average yield of soybeans for the Southeast Kansas Crop Reporting District and for the state.

Table 1.1. Soybean Production in Southeast Kansas and Kansas, 1968-1987.

Year	Acres Harvested			Yield in Bushels per Acre		Bushels Produced In SE Kansas as % of Kansas
	Southeast Kansas	Kansas	SE Kansas % of Kansas	Southeast Kansas	Kansas	
1968	435,300	957,000	45.49	23.1	25.0	42.03
1969	375,800	852,000	44.11	19.1	23.0	36.63
1970	413,930	1,005,000	41.19	13.2	15.0	36.24
1971	385,500	871,000	44.26	19.0	20.5	41.02
1972	371,420	875,000	42.45	24.0	28.0	36.38
1973	506,800	1,200,000	42.23	19.4	22.0	37.24
1974	376,500	1,030,000	36.55	19.2	20.0	35.09
1975	394,000	1,080,000	36.48	20.0	20.5	35.59
1976	356,200	865,000	41.18	15.2	15.0	41.73
1977	389,500	990,000	39.34	23.6	28.0	33.16
1978	573,200	1,450,000	39.53	15.2	18.0	33.38
1979	548,500	1,560,000	35.16	20.1	26.5	26.67
1980	453,300	1,450,000	31.26	9.5	16.5	18.00
1981	439,200	1,510,000	29.09	22.3	30.0	21.62
1982	527,500	1,810,000	29.14	21.1	26.0	23.65
1983	457,900	1,570,000	29.17	12.0	15.0	23.33
1984	492,400	1,620,000	30.40	10.8	17.5	18.76
1985	392,200	1,153,000	34.02	24.6	29.0	28.85
1986	502,400	1,495,000	33.61	24.7	32.5	25.54
1987	666,600	1,871,000	35.63	28.7	30.5	33.53
Ave	452,908	1,260,700	35.23	19.24	22.93	31.42
SD	79,777	326,616	9.68	5.03	5.56	7.38
CV	0.18	0.26	0.27	0.26	0.24	0.23

Source: Kansas State Board of Agriculture and Kansas Agricultural Statistics, Annual Reports of Kansas Farm Facts, 1969-1987.

Southeast Kansas includes the 14 counties in the SE Kansas Crop Reporting District.

significant portion of the soybeans in the state. In all but one of the last 20 years, more acres of soybeans were produced in Southeastern Kansas than in any of the other crop reporting districts. East-central Kansas harvested more soybeans than the Southeast in 1981. Acres of soybeans harvested within the last two years has increased for the state as well as for the southeastern corner.

Variability of soybean acres harvested and yield may be due to several factors. Production and therefore harvest of soybeans may be responsive to the price of soybeans in the previous year. In 1977 the average price of soybeans was \$6.61, this represented an increase of \$1.08 above the average price in 1976. In 1978 the acreage harvested in southeastern Kansas increased to 573,000 from 389,000 acres in 1977.¹ Similarly, the state's harvested acreage increased to 1,450,000 acres from 990,000 acres (Table 1.1). Soybean yield in southeastern Kansas may be affected by several factors. Variability in yield may be related to weather patterns of a particular year. Soil type in which soybeans are planted may also affect yield. Clay pans which exist in some soils in southeastern Kansas may reduce yield of soybeans relative to yields on better soils.

¹In a perfectly competitive economy relative prices of crops would determine the number of acres planted. However, with government programs limiting farmers' flexibility and the possibility to double crop soybeans after wheat, soybean price changes from year to year may influence acreage more than would otherwise be the case.

Irrigation of soybeans in Kansas is a practice which is primarily present in the western half of the state. Thus, southeastern Kansas relies on rainfall for soybean water requirements which may at times be inadequate. Thus, poor soil conditions and limited irrigation in southeastern Kansas may contribute to lower average yields in this area as compared to the rest of the state.

Information about three representative counties indicates that climatic conditions in Southeastern Kansas are favorable for the production of EMS. As described in the Soil Survey of Neosho County Kansas the climate is typical of continental weather patterns. Rainfall is heaviest in late spring and early summer due to the fairly dependable moisture laden air currents that come from the Gulf of Mexico. Average annual precipitation for Neosho county is 39.68 inches, of this, 27.11 inches fall between April and September. Prolonged dry periods occur during the summer months, when the average daily maximum temperature is 89.1 degrees Fahrenheit. These dry spells usually occur during mid to late July and August. The Soil Survey of Montgomery County Kansas and the Soil Survey of Cherokee County Kansas give weather and rainfall patterns similar to Neosho county. Table 1.2 shows the average annual rainfall pattern for the three example counties in southeastern Kansas.

Table 1.2 Average Monthly Precipitation Patterns
for Three Kansas Counties, 1941-1976.

	County		
	Cherokee	Montgomery	Neosho
	inches		
Jan.	1.44	1.25	1.30
Feb.	1.57	1.16	1.25
March	2.39	2.22	2.74
April	4.20	3.95	3.70
May	5.42	5.10	5.07
June	5.80	5.49	4.96
July	3.97	3.82	4.69
Aug.	3.19	2.97	3.88
Sept.	5.33	4.68	4.81
Oct.	3.40	3.26	3.53
Nov.	2.09	1.69	2.12
Dec.	1.72	1.36	1.63

Source: U.S. Department of Agriculture, Soil
Conservation Service, Soil Survey of
Cherokee County Kansas, 1985.

_____. Soil Survey of Montgomery
County Kansas, 1980.

_____. Soil Survey of Neosho County
Kansas, 1982.

July and August are the months when Group III through V soybeans typically flower and set and fill pods. Planted in late April, EMS flower and set and fill pods during late May, June and early July. Thus, EMS may have more favorable growing conditions and thus may yield as well as or better than traditional soybeans. Two years of research indicates that yield per acre of EMS may be the same or better than traditional soybeans (Granade 1987, 1988).

EMS may be economically viable even with lower yields than TS because prices of soybeans in July or August, when EMS are harvested, are typically higher than in October when TS are typically harvested (Table 1.3 and Figure 1.3). While marketing strategy may affect the desirability of EMS, analysis of alternative marketing strategies was beyond the scope of this study. This study assumes that soybeans are sold during the week of harvest in the cash market. Kansas Agricultural Statistics (1988b) reports that in 1987 58% of Kansas farmers sold their soybeans for cash on delivery. Compared to TS, EMS had higher prices in the cash market during the month of harvest in eleven of the sixteen years from 1970 through 1985. Thus, farmers may take advantage of the seasonal soybean price pattern by producing EMS.

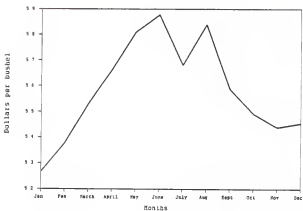
Capital requirements, in the form of the machinery complement may be the same for EMS as for traditional soybeans. With labor possibly being spread over a broader

Table 1.3 Average Monthly Soybean Prices Received by Farmers in Kansas,
1970 - 1985.

Year	Months												Year Average
	January	February	March	April	May	June	July	August	September	October	November	December	
1970	3.24	2.30	2.32	2.40	2.44	2.48	2.58	2.55	2.55	2.65	2.79	2.71	2.50
1971	2.73	2.82	2.84	2.77	2.83	2.88	3.10	2.97	2.93	2.89	2.78	2.88	2.87
1972	2.84	2.96	3.12	3.33	3.30	3.30	3.28	3.30	3.15	3.06	3.15	3.96	3.23
1973	4.04	5.44	5.98	6.10	8.50	10.00	6.50	8.70	6.10	5.85	5.16	5.56	6.49
1974	5.77	6.04	5.92	5.16	5.11	5.08	6.10	7.51	7.23	8.15	7.45	6.98	6.38
1975	6.05	5.53	5.18	5.52	4.91	4.81	5.29	5.60	5.24	4.89	4.33	4.10	5.12
1976	4.35	4.34	4.33	4.46	4.81	6.18	6.65	5.99	5.58	5.86	6.09	6.66	5.53
1977	6.73	7.07	8.04	9.26	9.07	7.88	5.97	4.96	4.84	4.75	5.34	5.35	6.61
1978	5.26	5.48	6.28	6.47	7.00	6.64	6.21	6.17	6.23	6.25	6.32	6.28	6.19
1979	6.48	6.96	7.07	7.07	7.00	7.22	7.30	7.05	6.66	5.97	5.97	5.97	6.72
1980	5.92	5.92	5.56	5.36	5.45	5.73	6.69	7.24	7.84	8.00	8.24	7.64	6.83
1981	7.58	7.06	7.13	7.26	7.07	6.70	7.02	6.73	5.90	5.77	5.77	5.73	6.65
1982	5.86	5.98	5.74	5.96	6.14	5.99	5.99	5.46	5.06	4.81	5.15	5.29	5.62
1983	5.33	5.47	5.62	5.95	6.00	5.96	6.16	7.83	8.33	8.27	7.76	7.56	6.69
1984	7.42	7.04	7.35	7.67	7.99	7.54	6.62	6.38	5.93	6.00	5.80	5.72	6.81
1985	5.67	5.62	5.82	5.88	5.61	5.66	5.44	5.00	4.73	4.70	4.84	4.93	5.33
Monthly Average	5.27	5.38	5.53	5.66	5.81	5.88	5.68	5.84	5.59	5.49	5.44	5.46	

^a United States Department of Agriculture, Department of Commerce,
Various Annual Summaries Agricultural Prices, 1970 - 1985. Cash
prices are in nominal dollars per bushel.

Figure 1.3 Seasonality of Average Soybean Price in Kansas,
1970-1985.



time frame for both planting and harvesting, more acres might be farmed with the same machinery complement. Additionally, the amount of labor during critical planting and harvesting periods needed to farm a given amount of cropland with a given machinery complement may be reduced.

Fieldwork hours and labor requirements for crop farm operators generally are most constraining during planting and harvesting of field crops. EMS are planted in the latter part of April as opposed to the middle of June, which is the typical time to plant traditional soybeans. In late May and June, grain sorghum is also planted, thus, traditional soybeans compete for field work hours and labor with grain sorghum at planting. Harvesting EMS in late July and early August does not compete with other major farming practices during this time. Traditional soybeans are harvested in October, competing with grain sorghum harvest and wheat drilling activities. Thus, EMS may fit nicely in southeastern Kansas farm plans where wheat, soybeans, and grain sorghum are the major crops produced. Since soybeans are grown in southeastern Kansas, farm operators are familiar with cultural practices for growing this crop and can make adaptations for this new system.

Objectives

The objective of this research is to investigate the economic potential of early-maturing soybeans in southeastern Kansas. Specifically, impacts of including EMS

on a representative farm will be evaluated in terms of impacts on returns, risk, seasonal labor, and field time requirements.

The following specific questions will be addressed.

- (1) What are the distribution characteristics of yields for EMS and TS in terms of mean and standard deviation?
- (2) How do variable input costs and returns per acre differ for EMS and traditional soybeans?
- (3) What economic incentives related to risk and returns exist for the inclusion of EMS in farm plans?

Overview of Thesis

The economic potential of EMS will be evaluated in the context of a representative crop farm in Southeastern Kansas. The analytical technique is a whole-farm linear programming model based on budgets generated from agronomic data gathered at the Southeast Kansas Branch Experiment Station. The linear program will include Target MOTAD parameters to investigate income and risk strategies for the representative farm.

Crop simulation will be used to generate 99 years of yield data for early-maturing soybeans and traditional soybeans. A crop simulation computer program, SOYGRO v5.41 will be utilized for cropping response modeling based on climactic, varietal, and soils data (Jones, et al).

The remainder of this thesis is organized as follows. Chapter two describes economic theory related to selection of optimal combinations of crops and EV analysis in a farm setting. Chapter three includes an explanation of the analytical procedures and data. Chapter four incorporates results and interpretation of results. Chapter five includes summary, conclusions, and suggestions for future research. Appendices contain budgets and detailed data that are not incorporated in the text.

CHAPTER II

CONCEPTUAL CONSIDERATIONS

Classical production economics and expected returns and variance (EV) analysis provide a conceptual basis for conducting a study investigating the combination of traditional soybeans and early-maturing soybeans to be grown on a representative crop farm in southeastern Kansas.

Assume that the farm manager wants to maximize profit. To achieve the goal of profit maximization, assume the farm operator of a crop farm in southeastern Kansas can consider alternative combinations of four crops -- wheat, grain sorghum, traditional soybeans and early-maturing soybeans. Because the farm operator participates in the government wheat and feedgrain programs, production of wheat and sorghum is determined by his base acres, set aside requirements, and typical input and yield levels. Thus, this analysis focuses on allocation of land not included in wheat and feedgrain bases, to traditional soybeans and EMS.

Economic Decision Criteria

Resources that can be allocated to activities by a farm manager are of varying types. The economic decision criteria by which they are allocated also vary by type of resource. Three types of resources are incorporated into production plans by farm managers: (a) variable resources that can be allocated among products, (b) resources that are

fixed to the farm but may be allocated among activities, and (c) resources that are fixed to both the farm and the activity and cannot be utilized in other production settings. In this study (b) is applicable. Variable resources such as labor, field time, fertilizer and pesticides may be allocated to the four crops, however, in this study only one level of variable inputs per acre is considered for each crop. Since production of wheat and grain sorghum occur within the confines of the government programs the allocation of land for these two crops may be considered fixed. Land, not included in wheat and feedgrain bases, is fixed to the farm but must be allocated between traditional soybeans and EMS.

Beattie and Taylor have classified the relationships between production activities as being economically independent or economically competing. Economically independent activities are also termed supplementary activities and economically competing activities are also referred to as simply competing activities (Doll and Orazem).

Agricultural products are economically competitive when two products need the same resource at the same time. Crop farms in southeastern Kansas have competing relationships between enterprises. Mathematically the relationship may be expressed by the following equation.

$$\begin{aligned} \text{MPPTs} &< 0 \\ \text{MPPems} \end{aligned}$$

MPPTs is the marginal physical product of land in traditional soybean production, and MPPems is the marginal physical product of land in EMS production. The above relationship states that the production of traditional soybeans is reduced by an increase in the production of EMS when resources are shifted from traditional soybeans to EMS. When EMS are being produced on one acre of land then traditional soybeans cannot be produced on that same acre of land. Enterprises requiring labor within the same time period compete for the operator/manager's labor. All activities on the representative farm are in competition for the limited capital resources available. It is the allocation of these resources by the manager among the chosen activities to maximize profit of the farm that necessitates decision making.

In multiproduct theory assumptions are made to facilitate analysis. These assumptions are: (1) The production functions of the economic activities on the farm are given. (2) Prices of the resources used in production and the prices of the outputs produced are known. (3) All the products are homogenous and infinitely divisible. (4) The goal of the operator is to maximize profit of the farm. (5) Resource and output prices do not change as use and

production of output changes. (6) Perfect mobility of resources and products.

Figure 2.1 illustrates graphically how traditional soybeans relate to EMS in a competitive environment. The horizontal axis represents traditional soybean production, the vertical axis represents EMS production. The curvilinear boundary represents the production possibilities curve, the straight line is the price line. At the point of tangency of these two lines the most profitable combination of EMS and traditional soybeans is found.

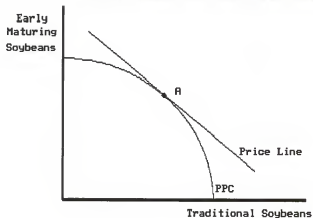
The general equimarginal principal states that the ratio of the value marginal product of an input to the unit price of the input be equal for all inputs in all enterprises (Doll and Orazem). At point A in Figure 2.1 this relationship holds for traditional soybeans and EMS.

Portfolio Theory

With classical production theory discussed above many options are available to the farm manager for utilization of resources to produce products in a framework of certainty. However, in farm production many things are uncertain and thereby have an element of risk. Portfolio analysis in the farm setting investigates the diversification of economic activities to reduce risk and enhance economic viability (Lee, et al.).

Risk preferences and utility functions are needed to analyze the combinations of activities to be included in the

Figure 2.1 Production Possibilities Curve (PPC) for Early-Maturing Soybeans and Traditional Soybeans

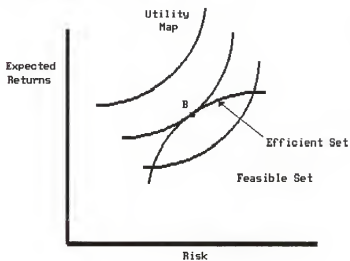


farm plan. Figure 2.2 illustrates how the basic components of portfolio theory are summarized using a utility map of a manager, a feasible set, and a risk and return frontier.

The axes are constructed such that the measurement of risk is placed on the horizontal axis, the measurement of expected returns is placed on the vertical axis. Thus, more risky activities are located more to the right in Figure 2.2. Similarly, the higher the expected returns, the higher the activity. The feasible set is all the possible combinations of risk and expected returns which fall on the feasible frontier and below. The frontier, sometimes called the efficient set, is efficient as it represents differing options of risky activities which provide maximum expected returns given levels of risk or minimum risk given levels of expected returns (Burton and Crisostomo).

The utility map of an individual is difficult to define. Empirical problems in measuring individual utilities as well as measuring aggregated utility across individuals exist (e.g. Young et al. and Robison and Carman). Thus, in this thesis a utility function will not be estimated. Instead an efficient frontier for the 700 acre farm will be generated and individual producers may select from possible combinations on the efficient frontier.

Figure 2.2 Portfolio Selection Model



CHAPTER III

METHODOLOGY AND DATA

Methodology for examining the incorporation of early-maturing soybeans into a representative farm involved five steps. Five steps were necessary to simulate a long-term series of soybean yields and to model crop production on a representative farm. First, a weather simulation model was used to generate necessary weather data. Second, the simulated weather data were input into a crop simulation model used to simulate both the early-maturing soybean and traditional soybean yields. Third, simulated yields and average costs were used to prepare crop production budgets on the representative farm. Fourth, a linear programming model was developed to determine if a profit maximizing farm would raise early-maturing soybeans. Fifth, the profit maximizing model was modified to consider risk using Target MOTAD methodology. Procedures and data associated with each of these five steps are discussed below.

Weather Data Generation

Weather requirements for the SOYGRO version 5.41 program are daily maximum and minimum temperatures in degrees Centigrade, daily precipitation in millimeters, and solar radiation in megajoules per meter squared. In order to assess yield variability a long-term data series of 100 years was desired. At the time this work was in progress

the author was not aware of such a long term data series for Labette or Cherokee counties in Kansas.² Thus, a weather generator, WGEN, (Richardson and Wright) was utilized to provide simulated daily observations for a representative location in southeastern Kansas.

Thirty-two years (1955-1987) of actual daily observations from Columbus, Kansas were used to calculate daily average maximum and minimum temperatures and precipitation. No observations for solar radiation were available. In calculating the average values, if a month had missing observations, that month was discarded from the averaging process. This resulted in the monthly averages being based on thirty to thirty-two years of data.

The average daily weather parameters from Columbus, Kansas were then used with the WGEN program to generate ninety-nine years of simulated data. A time period of 100 years was arbitrarily selected as desirable for a long-term data series. Ninety-nine years instead of 100 were generated because the input file of WGEN allowed only two digits for length of simulation. Output data were converted to the proper metric unit for temperature, rainfall, and solar radiation. Weather generation parameters, in addition to maximum and minimum temperatures, solar radiation and daily

²The author recently learned that a weather data series for Columbus, Kansas in Cherokee county from 1893 to 1988 is expected to be available in October 1989.

precipitation, such as monthly probability of a wet day following a wet day, from Tulsa, Oklahoma were included from a list of 136 stations in the country that have had these additional parameters measured. Tulsa was the closest station to Columbus, Kansas. Additional generation values were obtained from documentation for the WGEN program (Richardson and Wright pp. 52-57). A detailed discussion of WGEN's operations may be found in the program's documentation. A summary of the ninety-nine years of weather data is found in Table 3.1. In cases where possible monthly means of actual data do not differ widely from simulated data. A statistical test is needed to determine whether the monthly means are significantly different. Such a test was not performed because of the need for timely completion of the thesis.

Soybean Growth Simulation for Yield Estimates

Agronomic data on early-maturing soybeans have not been collected for a long enough time period to provide adequate data for this economic study especially risk analysis (Granade 1987, 1988, 1989). Thus, a computer simulation model (SOYGRO version 5.41) was used to simulate soybean growth and resulting yields of both traditional soybeans and EMS for a southeastern Kansas location.

Table 3.1. Weather Summary for 99 Year Simulation with Actual Data for Comparison

	MONTHS												Year
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Wet Days	6.08	7.75	7.15	8.60	10.12	7.75	7.25	6.03	7.33	5.86	6.04	7.05	87.01
Act. Wet Days	na	na	na	na	na	na	na	na	na	na	na	na	na
Rainfall	1.50	1.97	2.87	3.57	5.65	5.34	3.33	3.86	5.00	4.55	3.36	2.19	43.19
Act. Rainfall	1.46	1.72	3.05	3.58	5.37	5.09	3.39	3.82	4.88	3.91	3.33	2.02	41.62
Ave. Max Temp.	42.59	48.03	58.80	70.45	78.01	85.65	91.39	90.41	82.46	72.72	57.20	47.19	68.74
Act. Ave. Max. Temp.	42.40	48.50	58.50	69.80	77.80	85.20	91.10	90.20	82.60	72.40	57.90	46.80	68.60
Ave. Min. Temp.	21.77	26.56	35.61	46.16	55.87	63.66	68.14	65.73	58.74	47.85	35.90	27.14	46.09
Act. Ave. Min. Temp.	21.60	27.10	35.40	45.90	55.60	63.40	67.90	65.60	58.50	47.30	35.90	26.80	45.92
Ave. Radiation	211.77	272.79	377.77	476.37	546.56	597.85	582.36	517.22	405.32	309.09	227.09	187.90	392.67
Act. Ave Radiation	na	na	na	na	na	na	na	na	na	na	na	na	na

^aRainfall is reported in inches. Temperature is reported in degrees Fahrenheit. Solar radiation is reported in inspoys. The abbreviation na indicates that data was not available. These data are a summarization of weather generation using WGEN and actual weather observations from Columbus, Kansas.

model (SOYGRO version 5.41) was used to simulate soybean growth and resulting yields of both traditional soybeans and EMS for a southeastern Kansas location.

SOYGRO (Jones et al.) uses five general location specific parameters to simulate soybean growth. These five parameters are (1) soil profile characteristics; (2) daily weather data; (3) variety phenotypic information; (4) cultural practices; (5) longitude and latitude.

Parsons silt loam was the soil selected to include in the soil parameters for soybean simulation. This soil series is the soil type upon which the Southeast Kansas Branch Experiment Station is located. Thus, simulated yields may be compared to the few years of actual data. Input data for the format required by SOYGRO were obtained from the Parsons soil series description (SCS 1984) and from Parsons soil primary characterization data (SCS 1987). Computations to transform these data to the format required by SOYGRO followed procedures outlined by Ritchie et al.

Daily weather data were generated by the WGEN program as discussed earlier. SOYGRO uses maximum daily temperature, minimum daily temperature, daily precipitation and solar radiation. The ninety-nine years of weather data randomly generated for the location in southeastern Kansas were used to generate ninety-nine annual yields for both EMS and traditional soybeans. Procedures for the inclusion of

the weather information are given in the documentation of SOYGRO by Jones et al.

Within SOYGRO, variety phenotypic information is available for several cultivars of soybeans as well as generic phenotypic information. This study utilizes the phenotypic data for Essex soybeans as representative of the group V soybeans grown in southeastern Kansas. Essex soybeans have performed well in performance tests conducted by the agronomists at the Southeast Kansas Branch Experiment Station. Insufficient phenotypic information exists for a specific cultivar of group I which is currently grown in southeastern Kansas. Thus, for the group I soybean phenotypic information a generic data set was used as provided by the SOYGRO program (Jones et al. p. 47).

Cultural practices such as seeding rate, planting depth, planting date, row spacing, and plant density are used by SOYGRO to simulate crop growth. For EMS a seeding rate of 87.27 pounds per acre, planting date of April 25, planting depth of one and one half inches, row spacing of seven inches, and plant density of 68 plants per square yard were used in the model. Traditional soybeans had a seeding rate of 36.1 pounds per acre, planting date of June 10, planting depth of one and one half inches, row spacing of 30 inches and a plant density of slightly over 27 plants per square yard. These cultural practices are used in the on-going EMS research at the Southeast Kansas Branch Experiment

Station. The higher seeding rate and plant density for EMS were used because soil temperatures are lower in April and germination may not be as successful and planting method was drilling thereby having narrower row spacings. For the ninety-nine years of simulation, planting date was assumed to be constant. If the weather generator gave data for either of the two planting dates as having had a rain the simulation continues as the program interprets the soil profile as being at or above field capacity. Of course, in actual field conditions this is not possible. Soybean simulation begins January 1 of every year and terminates at harvest maturity. Simulated growing seasons of both EMS and traditional soybeans were very close to actual observed growing periods.

Longitude and latitude of Parsons, Kansas were used to give the SOYGRO model solar data for day length and geographical position. Longitude of 37.2N and latitude of 95.2W represent the position of Parsons.

A summary of the yields generated using SOYGRO is found in Table 3.2. Yield values were higher from the simulation than are being observed in southeastern Kansas. These higher yields may have occurred because the simulation model did not include impacts from disease and pest problems. The simulated yields were multiplied by 0.5940 to bring the mean of the ninety-nine years to the observed mean of the

Table 3.2. Summary of 99 Years of Soybean Yield Simulation and Adjustment to Yields and Analysis of Ten-Year Periods.

Year	Trad. Soybeans	Early Maturing Soybeans	Adjustment .5940 TS	Factor .5940 EMS		TS	EMS
1	54.9	56.4	32.6	33.5	Mean 1	25.8	32.1
2	37.2	53.1	22.1	31.5			
3	48.7	50.3	28.9	29.9	Std 1	8.2	2.5
4	24.3	47.2	14.4	28.0			
5	50.6	58.6	30.1	34.8	Variance	67.6	6.3
6	52.7	59.7	31.3	35.5			
7	11.8	48.7	7.0	28.9			
8	52.7	51.5	31.3	30.6			
9	53.7	58.5	31.9	34.7			
10	48.1	56.1	28.6	33.3	Mean 2	29.3	23.2
11	59.8	59.5	35.5	35.3			
12	57.3	56.1	34.0	33.3	Std 2	7.8	10.6
13	54.6	29.3	32.4	17.4			
14	53.7	39.7	31.9	23.6	Variance	60.2	111.8
15	52.2	0.0	31.0	0.0			
16	48.8	47.2	29.0	28.0			
17	14.9	21.9	8.9	13.0			
18	58.8	31.3	34.9	18.6			
19	37.1	50.0	22.0	29.7			
20	56.6	56.3	33.6	33.4	Mean 3	26.6	24.6
21	51.1	20.5	30.4	12.2			
22	47.8	33.4	28.4	21.0	Std 3	9.4	6.2
23	53.7	46.7	31.9	27.7			
24	59.4	47.0	35.3	27.9	Variance	88.4	39.0
25	59.5	46.7	35.3	27.7			
26	21.6	49.3	12.8	29.3			
27	51.9	28.3	30.8	16.8			
28	31.7	58.3	18.8	34.6			
29	12.9	37.7	7.7	22.4			
30	57.9	45.0	34.4	26.7	Mean 4	29.8	29.5
31	41.5	52.7	24.7	31.3			
32	40.2	59.7	23.9	35.5	Std 4	4.5	6.9
33	41.2	25.3	24.5	15.0			
34	60.1	58.9	35.7	35.0	Variance	20.2	47.9
35	55.7	55.8	33.1	33.1			
36	42.6	35.3	25.3	21.0			
37	53.9	59.4	32.0	35.3			
38	51.8	37.8	30.8	22.5			
39	54.9	57.8	32.6	34.3			
40	59.8	54.5	35.5	32.4	Mean 5	27.6	22.6
41	51.9	33.2	30.8	19.7			
42	50.0	37.1	29.7	22.0	Std 5	7.0	7.8
43	57.6	58.3	34.2	34.6			
44	54.8	34.5	32.6	20.5	Variance	49.5	61.2
45	21.9	51.8	13.0	30.8			
46	29.5	15.3	17.5	9.1			
47	36.9	32.2	21.9	19.1			
48	55.8	22.6	33.1	13.4			
49	55.1	55.5	32.7	33.0			
50	51.2	40.0	30.4	23.8	Mean 6	29.1	26.6
51	53.6	36.6	31.8	21.7			
52	57.6	59.1	34.2	35.1	Std 6	6.8	9.1
53	29.0	31.4	17.2	18.7			
54	52.8	20.2	31.4	12.0			

Table 3.2 Continued

Year	Early		Adjustment Factor			TS	EMS
	Trad. Soybeans	Maturing Soybeans	.5940	.5940			
55	57.5	59.1	34.2	35.1	Variance	46.2	82.5
56	52.1	25.3	30.9	15.0			
57	26.8	38.0	15.9	22.6			
58	44.7	60.3	26.6	35.8			
59	53.3	58.5	31.7	34.7			
60	<u>62.7</u>	<u>59.7</u>	<u>37.2</u>	<u>35.5</u>			
61	54.2	55.7	32.2	33.1	Mean 7	26.2	26.6
62	52.8	32.7	31.4	19.4			
63	52.2	48.8	31.0	29.0	Std 7	7.1	6.3
64	56.1	50.6	33.3	30.1			
65	43.8	42.6	26.0	25.3	Variance	50.0	39.1
66	44.5	57.8	26.4	34.3			
67	58.3	34.5	34.6	20.5			
68	52.1	58.2	30.9	34.6			
69	14.6	39.1	8.7	23.2			
70	<u>45.5</u>	<u>27.4</u>	<u>27.0</u>	<u>16.3</u>			
71	53.3	55.5	31.7	33.0	Mean 8	28.3	28.7
72	54.2	54.6	32.2	32.4			
73	52.2	57.2	31.0	34.0	Std 8	7.1	5.6
74	41.1	43.5	24.4	25.8			
75	57.0	50.0	33.9	29.7	Variance	49.8	31.0
76	55.2	53.6	32.8	31.8			
77	52.7	42.7	31.3	25.4			
78	42.7	34.1	25.4	20.3			
79	15.3	31.7	9.1	18.8			
80	<u>53.3</u>	<u>60.3</u>	<u>31.7</u>	<u>35.8</u>			
81	31.1	49.0	18.5	29.1	Mean 9	28.4	28.4
82	56.3	48.2	33.4	28.6			
83	60.0	54.2	35.6	32.2	Std 9	6.9	6.2
84	55.2	41.2	32.8	24.5			
85	34.1	56.7	20.3	33.7	Variance	47.5	37.9
86	51.9	50.3	30.8	29.9			
87	45.5	58.6	27.0	34.8			
88	57.3	28.0	34.0	16.6			
89	58.5	59.4	34.7	35.3			
90	<u>28.4</u>	<u>31.7</u>	<u>16.9</u>	<u>18.8</u>	Mean 10	23.9	27.6
91	57.2	59.8	34.0	35.5			
92	55.2	52.8	32.8	31.4	Std 10	7.5	7.1
93	35.0	58.2	20.8	34.6			
94	17.6	52.2	10.5	31.0	Variance	55.8	49.9
95	32.3	28.3	19.2	16.8			
96	41.7	42.1	24.8	25.0			
97	46.3	29.2	27.5	17.3			
98	55.4	58.2	32.9	34.6			
99	32.6	51.4	19.4	30.5			
MEAN	46.8	45.6	27.8	27.1			
STD	12.6	12.8	7.5	7.6			
VARIANCE	158.3	165.1	55.9	58.2			

Note: The underlined sections represent individual ten-year periods. Since there were 99 years simulated the tenth period was determined by using the last year in the ninth period. The abbreviation STD represents standard deviation. For this study the fourth period was used for the initial ten years, the second period was used for the sensitivity analysis.

traditional soybeans in the EMS study being conducted at the Southeast Kansas Branch Experiment Station (Granade). This was recommended by Dr. Richard Vanderlip an agronomist at Kansas State University as a logical adjustment procedure based on his experience with crop simulation models. Dr. Vanderlip felt such a procedure would provide reasonable yields levels and an estimate of yield variability. Yield variability of the output was retained with this adjustment as all yields were reduced by this adjustment factor. It was assumed that technology was held constant over the ninety-nine year periods. So, there is no trend in the data due to improvements in technology.

The 99 years data were divided into ten ten-year periods so that two ten-year periods could be selected for whole-farm modeling. A ten-year period was long enough to provide a distribution of yields but short enough not to be a burden for whole-farm modeling. Ten-year periods were analyzed as to mean, standard deviation, variance, and number of years that EMS out yielded traditional soybeans. An initial ten-year period (period 4 in Table 3.2) was selected as the ten-year period that was most like the ninety-nine year period in terms of mean, standard deviation, variance and proportion of years EMS out yielded traditional soybeans. The ninety-nine years of simulation were adjusted to have a mean of 27.8 bushels per acre. The average of soybean yields for Labette County, Kansas from

1984 to 1988 reported by Kansas Agricultural Statistics was 20.7 bushels per acre. Thus, yields adjusted to correspond to experiment station yields were greater than county averages over the last five years. Standard deviation of traditional soybeans was 7.5 bushels, and variance was 55.9 bushels for traditional soybeans. Forty-six of the ninety-nine years EMS had a higher yield than traditional soybeans. A second ten year period (Period 2 in Table 3.2) was selected for sensitivity analysis. This ten year period was the period least favorable to EMS production. A summary of the ten-year periods and the two selected for whole-farm modeling is shown in Table 3.2.

Budgeting of Crop Activities

Crop budgets were constructed to reflect returns over variable costs. From the ten-year period that was used, budgets for EMS and traditional soybeans were generated. A sample budget is presented in Table 3.3. Budgets for wheat and grain sorghum activities were also generated in a similar manner to be included in the whole-farm model. Output price for the soybean crops were obtained from Grain and Feed Market News for the most recent ten years. The prices for the soybeans were from the predicted week of harvest; weekly cash bids from Kansas City, Kansas country elevators. For both grain sorghum and wheat, output price was the monthly average price for the month of harvest as reported in Agricultural Prices. To remove the impact of

Table 3.3. Group One Soybean Budget planted April 25,
Persons, Kansas

	Unit	Price	Quantity per acre ^a	Value or cost
1. Gross Receipts from Production	bu.	\$6.32 ^b	31.30	\$197.82
Total receipts				\$197.82
2. Variable costs ^c				
Seed	lbs.	\$0.16	87.27	\$13.96
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	2.00	\$20.00
Herbicide ^d				\$15.75
Insecticide				\$0.00
Labor ^e	hr.	\$6.00	0.91 ^h	\$5.46
Machinery cost ^e				\$12.58
Misc. costs ⁱ				\$8.42
Interest on 1/2 of variable cost	Dol.	\$0.12	37.67	\$4.52
Total Variable Cost				\$79.85
3. Income above variable cost				\$117.96

^a Yields are based on adjusted output from SOYGRD vs. 5.41 from a selected ten year portion of 99 years of simulation, see Table 3.2.

^b Output price is based on average of weekly cash bids at country elevators, USDA, Grain and Feed Market News, Vol. 27, No. 33, 1979, pg. 7, Kansas City area elevators in Kansas.

^c Input requirements other than machinery costs are from George Gransde et the S. E. Kansas Branch Experiment Station (SEKBES).

^d Herbicide prices, Dual @ 2pt/A \$11.26, Lexone DF @ 1/4lb/A \$4.49 prices and rates are from George Gransde at the SEKBES.

^e Machinery costs are from App. Table C 48.

^f Lime applied every 3-5 years as needed, all lime charged to budget in year applied.

^g Labor cost from Prices for Forward Planning, KSU Farm Management Guide MF 525, August 1988.

^h Labor amount from App. Table C 42.

ⁱ Miscellaneous costs from Southeast Kansas Farm Management Association, costs of fees, publications and miscellaneous costs divided by 700 acres.

inflation all output prices were adjusted to 1988 dollars using the Prices Received by Farmers Index as reported in Summary of Current Business.

Wheat and grain sorghum are government program crops for which farmers may or may not receive a deficiency payment. Deficiency payments in this study were calculated by subtracting the cash price at harvest from a target price. This calculation will generally result in a value of the deficiency payment per bushel being high since actual payments are based on a formula using five month and twelve month average prices. Historically the low for commodity prices is at harvest. The calculated deficiency payment is multiplied by the program yield and that value is added to cash receipts. In Appendix C, the program yields for wheat and grain sorghum are found in Tables C21-C40 in the row for government payments.

One consequence of using historical prices and simulated weather data is that output prices for soybeans do not follow long-term production patterns which are affected by weather for the simulated yield. Prices would generally be expected to be negatively correlated with yields. As modeled this may not necessarily hold. However, the important relationship between soybean prices in August and October is captured by use of historical prices.

Yields for wheat and grain sorghum come from test averages of Performance Tests conducted by Experiment

Station personnel in Southeast Kansas from the past ten years. Prices for these two crops and their respective yields are correlated as one would expect.

Since soybean yields were simulated the wheat and grain sorghum yields were independent from soybean yields. Variability of whole-farm income would likely be greater if soybean yields, wheat yields, and grain sorghum yields were based on the same weather data.

Variable input costs were in 1988 dollars. Input requirements for traditional soybeans and EMS were obtained from George Granade at the Southeast Kansas Experiment Station. Input requirements for wheat and grain sorghum activities were obtained from 1988 KSU Farm Management Guides for production of these two crops in eastern Kansas (Figurski and Schlender). Miscellaneous costs were calculated from averages from the Southeast Kansas Farm Management Association (Kansas Cooperative Extension Service).

Discussions with scientists at the Southeast Kansas Experiment Station led to the selection of a representative machinery compliment for the representative crop farm to be modeled. Prices for the machinery and field time required to perform operations come from Fuller and McGuire. Machinery cost per operation is calculated in Table C48 in Appendix C. Labor budgets were constructed to calculate total field hours per acre and labor hours and associated

costs to be included in the crop budgets. Incomes from the activities are measured by the differences between receipts (cash plus government payments if any) and variable costs.

Annual and average net returns are shown in Table 3.4 for the two ten-year periods studied. Appendix C contains the forty crop production budgets used in this study, machinery complement and machinery operations used and associated field time and labor requirements.

The initial economic model utilized in this study is the familiar linear program for profit maximization. Linear programming (LP) is a mathematical programming technique which assumes that decision making is done in the context of certainty (Crisostomo et al.).

Linear Programming

The LP model is constructed so that the objective function is to maximize profit for five land use activities, early-maturing soybeans, traditional soybeans, wheat, grain sorghum, and set-aside acres. Along with the land use activities there are weekly labor hiring activities for the months of April through October. Total land available is included as a constraint. Field work hours are included for the months of April through October. The field work days are calculated from 1982 through 1988 Crop-Weather reports published each week from farmer surveys by Kansas Agricultural Statistics (Appendix C). Hours available for

field work per day are assumed to be ten (Buller et al.). The LP model may be seen in Table 3.5 in a simplified form.

Target MOTAD

Correlation coefficients between returns above variable costs for EMS and traditional soybeans indicate that risk may be reduced by diversification. In the initial period the correlation coefficient of EMS to traditional soybeans was 0.69033 and for the sensitivity analysis period 0.16972. In the sensitivity analysis period the lower coefficient value indicates that diversification into EMS would likely reduce risk more when compared to the initial period with the higher coefficient value.

To account for risk, or uncertainty, a Target MOTAD (minimization of total absolute deviations) model is utilized to study four cropping activities and one set-aside activity on a representative farm in southeastern Kansas. Target MOTAD models may be easily solved using linear programming algorithms.

This study utilizes a Target MOTAD model similar in construction to models used by Crisostomo et al., Tauer, and Watts et al. The model specification shown below is taken from Crisostomo et al.

Table 3.4a. Incomes above Variable Costs for Four Crops for Initial Ten-Year Period (Period 4 on Table 3.2).^a

Year	EMS ^b	TS ^b	Wheat	Grain Sorghum
xx01	\$117.96	\$ 68.66	\$200.32	\$229.21
xx02	187.36	114.57	141.76	(17.42)
xx03	33.00	85.26	127.16	74.34
xx04	116.50	142.18	111.51	73.14
xx05	223.69	228.79	97.31	23.48
xx06	91.92	120.95	159.16	64.62
xx07	161.97	142.88	107.60	135.69
xx08	103.97	191.21	87.10	174.77
xx09	216.43	184.73	(45.09)	183.98
xx10	216.75	225.21	195.64	168.67
Average	\$146.96	\$150.44	\$118.45	\$111.05

Table 3.4b. Incomes above Variable Costs for EMS and TS in Sensitivity Analysis Ten-Year Period (Period 2 on Table 3.2).

Year	EMS ^b	TS ^b
xx01	\$143.24	\$131.95
xx02	172.12	198.18
xx03	47.66	130.45
xx04	52.54	121.21
xx05	(58.65)	210.79
xx06	142.11	146.67
xx07	22.60	0.12
xx08	72.11	223.97
xx09	179.54	106.82
xx10	225.25	210.22
Average	\$ 99.65	\$148.04

^a Incomes above variable costs come from budgets in Appendix C; sensitivity analysis incomes were calculated by changing only the simulated yields for the EMS and traditional soybean budget. Thus, wheat and grain sorghum remain the same in the sensitivity analysis.

^b EMS is an abbreviation for early-maturing soybeans, TS is an abbreviation for traditional soybeans.

Table 3.5 Simplified Linear Programming Model^a

Constraints	ACTIVITIES						RHS
	EMS	TS	WHEAT	SORGHUM	SETASIDE	HIRING LABOR	
OBJ Function	+	+	+	+	-	-	
Land	+	+	+	+	+		+
Wheat base			+				+
Feed grain base				+			+
Setaside					+		+
Field Time	+	+	+	+		-	+

^a Sign convention: (+) indicates usage or demand, (-) indicates supply. There are 31 weekly hiring activities. There are 31 weekly field-time constraints.

$$\text{Max } E(R) = \bar{R}(X) \quad (1)$$

$$\text{Subject to: } A(x) \leq B \quad (2)$$

$$RX + d \geq T \quad (3)$$

$$Pd \leq D \quad (4)$$

$$X, d \geq 0 \quad (5)$$

where X is a choice variable from an $n \times 1$ vector of activity levels; \bar{R} is an $1 \times n$ vector of expected returns for each activity; A is a resource requirement vector $k \times n$; B a $k \times 1$ vector of resource levels; T a $m \times 1$ vector with each element equal to a target return; R is an $m \times n$ matrix of annual returns from chosen activities; d is a $m \times 1$ vector of negative deviations from a target; P is a $1 \times m$ vector of probabilities of each observation; D is a scalar; n is the number of activities; m is the number of observations and k is the number of resource constraints. In (3) the d parameter measures the amount of annual income below the selected target. These negative deviations are multiplied by the probability of each observation and summed to give a value of the total deviations below the selected target. The total negative deviations, provide a value of risk (Crisostomo et al.).

The risk measure, D in the empirical model of a representative southeastern Kansas farm is changed to find alternative solutions. These alternative solutions differ in terms of risk, expected returns and activity levels. Low levels of D typically result in infeasible solutions. So

the first feasible solution is found by increasing D. Then D is further increased to discover additional solutions. A final solution, identical to the LP solution, is found when D gets so large that further increases in the risk measure will not change the activities selected.

Table 3.6 shows a simplified form of the Target MOTAD model used in this study. The objective function, five land use activities, and weekly labor hiring activities and associated constraints are the same as for the LP model. Ten columns for negative deviations from a target provide the balance of the columns for the matrix.

Ten constraint rows following the field time constraints relate annual gross margins from crop production and labor hiring activities to the target income. The ten observations on annual income are treated as equally likely to occur and therefore are each assigned a value of 0.1 in the model. The last row in the matrix calculates the sum of annual negative deviations and provides a method of calculating alternative return-risk efficient solutions by changing the risk measure in the model, the variable D. In viewing the Target MOTAD model in Table 3.6, the previously discussed LP matrix may be found by removing the ten negative deviation columns and the annual income and risk rows.

Table 3.6 Simplified Target MDTAD Model^a

Contrainte	ACTIVITIES						RHS
	ENS	TS	WHEAT	SORGHUM	SETASIDE	HIRING LABOR NEGATIVE DEVIATIONS	
Obj Function	+	+	+	+	-	-	
Land	+	+	+	+	+		+
Wheat base			+				+
Feed grain base				+			+
Setaside					+		+
Field Time	+	+	+	+		-	+
Annual Income	+	+	+	+	-	-	Target
Risk							.1 0

^a Sign convention: (+) indicates usage or demand, (-) indicates supply. There are 31 weekly hiring activities. There are ten annual negative deviations. There are 31 weekly field time constraints. There are ten annual incomes.

The target income selected for this study comes from the Kansas Farm Management Association 1988 Records Report, Management Information for the Southeast association. It is the summation of the following average data: family living expenses, income taxes, self employment taxes, life insurance, long-term debt payments (principal and interest amortized at 8.56%³ over 15 years), intermediate debt payments (principal and interest amortized at 9.18%⁴ over seven years), real estate taxes, personal property taxes, general farm insurance; and depreciation of vehicles, machinery, and buildings. The target in this study was \$60,161.

³As reported in Survey of Current Business for Farm Credit Administration long term loans for January 1988. Vol. 68, No.11, Nov. 1988.

⁴As reported in Business Conditions Digest, January 1989 for bank rates on short-term business loans.

Chapter IV

RESULTS AND DISCUSSION

In accordance with the research questions listed in Chapter I, results of this investigation of the economic potential of early maturing soybeans are divided into three sections. First, based on the crop simulation mentioned in Chapter III, yield distribution characteristics of early-maturing soybeans and traditional soybeans are compared. Second, budgeted differences in input costs and returns of EMS and traditional soybeans are discussed. Third, results from Target MOTAD linear programming models representative of southeastern Kansas crop farms are used to evaluate economic incentives for including EMS in farm plans. In order to explain procedures for developing the representative farm model, some of the results associated with the yield distributions and measurement of costs and returns were presented in Chapter III. These results are referenced but generally not repeated in Chapter IV.

Characteristics of Soybean Yield Distributions

Yields from the simulations of early-maturing soybeans and traditional soybeans for southeastern Kansas will be discussed in terms of (1) their adjustment, (2) mean and standard deviation, (3) relationship to two years of

agronomic research data (Granade 1988 and 1989). Results of simulations are in Table 3.2.

Simulation of plant growth of EMS and traditional soybeans resulted in yields higher than dryland yields generally observed in southeastern Kansas. An adjustment in yields of both EMS and traditional soybeans was undertaken to bring the simulated yields to lower levels. Continuing research with EMS versus traditional soybeans by Granade provides two years of actual data. Simulated yields were multiplied by a factor of 0.5940 to make the average for the ninety-nine years of simulated yields for traditional soybeans equal to the two-year average for Groups III, IV and V reported by Granade. The adjusted means of the ninety-nine years of simulated yields were then 27.8 bushels per acre for traditional soybeans and 27.1 bushels per acre for EMS.

Results from the current study at the Southeast Kansas Branch Experiment Station provide a relationship between means of Group I EMS and Group V traditional soybeans different from that of the simulated yields. Two years of data result in a mean of Group I soybeans of 27.95 bushels per acre and Group V soybeans have a mean of 25.25 bushels per acre (Granade 1988, 1989). Thus, two years of actual data indicate average Group I EMS yields greater than average Group V traditional soybeans while simulation results indicate larger average yields for traditional

soybeans. This may indicate that the simulation model needs to be adjusted further to Kansas conditions. However, the actual agronomic experiment is to be continued; so more conclusive data should be forthcoming. The simulation resulted in a killing freeze in year fifteen's spring, therefore, the yield for EMS was zero that year. On an actual farm, operators could plant traditional soybeans in a year when EMS fail. This added flexibility was not considered in this study. Even with the zero yield for EMS one year of the ninety-nine, variability was similar to traditional soybeans. The standard deviation of traditional soybeans was 7.5 bushels and for EMS 7.6 bushels.

Costs and Returns for Two Soybean Production Systems

Budgets detailing input requirements for EMS and traditional soybeans for the representative southeastern Kansas crop farm are the basis for the following discussion. Tables C1 through C20 in Appendix C are the budgets for EMS and traditional soybeans. Appendix C also contains various support tables such as labor and machine time requirements and field operation sequencing.

Differences in cultural practices between EMS and traditional soybeans result in differences in variable costs for machinery, labor, and seed. Variable interest expense is also different since it is calculated as a percentage of other costs.

Differences in machinery operations for traditional soybeans and EMS are seedbed preparations, planting methods (row planting versus drilling), and row cultivating (Appendix C Tables C42 and C43). Thus, machinery requirements per acre for EMS are less than those required for traditional soybeans. EMS require \$11.74 of machinery expenses as compared to traditional soybeans which require \$14.39 per acre. Thus, EMS requires \$2.65 per acre less in machinery costs.

Labor requirements are directly tied to machinery requirements. Labor required for one acre of EMS is 0.91 hours, worth \$5.41 when the wage rate is \$6.00 per hour. Labor required for one acre of traditional soybeans is 1.36 hours, worth \$8.16. Thus, EMS requires less labor than traditional soybeans at a savings of \$2.75 per acre.

A seeding rate of more than double that of traditional soybeans is required for EMS. This increased seeding rate is necessary to compensate for cooler soil temperatures and resulting lower germination rates for EMS as compared to traditional soybeans. Seed costs for EMS are \$13.96 per acre, included in this price is a two cent cost per pound higher than the price for traditional soybean seed due to transportation cost from the northern growing areas. Traditional soybeans require a cost of \$5.05. The \$8.91 higher seed costs of EMS compared to traditional soybeans offset the savings in labor and machinery costs.

Interest on one half of the variable costs is \$.21 higher for EMS. Thus, total variable costs for EMS are \$3.77 per acre higher than total variable costs for traditional soybeans.

In some years increased costs of EMS will be offset by higher cash prices of soybeans in August as compared to October cash prices. For eight of the ten years modeled cash prices of soybeans were higher in August than in October (Tables C1 through C20 in Appendix C). However, incomes above variable costs for EMS were higher than traditional soybeans only four of the ten years in the initial ten-year period (Table 3.4a). Price advantage of early soybeans could be offset by other marketing strategies for traditional soybeans. But, since most growers in Kansas sell in the cash market (Kansas Agricultural Statistics, 1988b) it was assumed that farmers sell in a cash market in this study. For the ten years in the sensitivity analysis period, income above variable costs was higher for three years for EMS as compared to traditional soybeans. An economic analysis based on research at the Southeast Kansas Branch Experiment Station, indicates that for the two years of actual data available Group I EMS produced incomes above variable costs higher than Group V traditional soybeans (van der Hoeven et al.) This income advantage for Group I was \$37.42 per acre when 1987 and 1988 results were averaged for Group I and Group V soybeans. In this study average income

above variable costs was \$3.96 per acre lower for EMS in the initial period and \$48.19 per acre lower for EMS in the sensitivity analysis (Table 3.4).

Economic Incentives for Including EMS in Representative Farm Plans

Target MOTAD models, representative of southeastern Kansas crop farms, are used to investigate economic incentives for adopting EMS. Five Target MOTAD model solutions are presented in the discussion; three based on yield data from the initial time period and two based on yield data from the sensitivity analysis time period. The three solutions based on the initial time period are, (1) a base model in which EMS is not included as a production alternative, (2) the first feasible solution when EMS are included as an alternative, and (3) a solution with the same activity levels as the LP solutions when EMS are included as an alternative. The two solutions based on the sensitivity analysis time period, both from models that allowed EMS as an alternative are (4) the first feasible solution and (5) a solution with the same activity levels as the LP solution. A base model that does not allow EMS production for the sensitivity analysis is not necessary because no EMS were produced in the fifth solution.

The discussion will entail four specific topics. First, an overview of results from the five solutions is presented in terms of income above variable costs, acres of

crop producing activities, and risk levels. Second, labor hiring activities are discussed. Third, shadow prices are analyzed. Fourth, income surpluses and negative deviations from the target income of \$60,161 are discussed.

Results indicate that EMS, when incorporated into a representative southeastern Kansas crop farm reduced risk and may increase or decrease income above variable costs. Risk is measured as the total of annual negative deviations from a target income. The initial analysis is based on a ten-year period selected from the crop simulation results as most similar to the whole ninety-nine years of simulations (Table 3.2). For the base model, when EMS are not included, the income is \$79,366 and risk is \$776 (Table 4.1). The income of the LP solution when 66 acres of EMS are grown is \$79,378 and risk is \$412. Thus, the objective function is increased \$12 and the risk measure is reduced \$364. Risk may be further reduced to \$360 by increasing EMS production to 89 acres. But, this lowers income to \$40 less than income in the farm plan with no EMS. The sensitivity analysis is based on the ten-year period least favorable to EMS production in the ninety-nine year simulation (Table 3.2). In the LP solution for the sensitivity analysis no EMS are produced. Despite the generally low yields for EMS in the sensitivity analysis risk can be reduced \$386 if 38 acres of EMS are produced. But this reduction in risk is associated with a \$1676 reduction in income.

Table 4.1. Objective Function, Land Use Activities and Risk for Solutions from Target MOTAD Models of a Representative Crop Farm in Southeastern Kansas.^a

	Models Including EMS as an Alternative				
	Initial Analysis			Sensitivity Analysis	
	Model Without EMS	First Feasible Solution	LP Solution	First Feasible Solution	LP Solution
Objective Function	\$79,366	\$79,326	\$79,378	\$77,186	\$78,862
Acres EMS	0	89	66	38	0
Acres TS	210	121	144	172	210
Risk Measure	\$776	\$360	\$412	\$2,397	\$2,783

^a Several alternative solutions exist for the initial ten-year period. The solutions here are the LP solution and the first feasible solution at their respective lowest level of the risk measure. Other solutions are not reported because differences from reported solutions are small. EMS is an abbreviation for early-maturing soybean, TS for traditional soybeans. The objective function maximized returns above variable costs. The measure of risk is the total of annual negative deviations from a target income. In accordance with the 1989 U.S. commodity program and base acreages on the 700 acre farm, all solutions contained 252 acres of wheat, 189 acres to grain sorghum, and 49 acres of sorghum. Results are rounded to the nearest whole number.

Risk dominance occurs when one solution has lower risk and higher or the same income as a second solution when the two are compared (Barry, Hopkins, and Baker). Since, the initial ten-year period LP solution with 66 acres of EMS has a higher income and lower risk, it dominates the initial analysis solution in which EMS are not considered an alternative. Since the solution with 66 acres of EMS dominates the base model with no EMS, the operators utility function need not be known; the solution with EMS will always be preferred over the solution with no EMS.

In the first feasible solution of the initial analysis with 89 acres of EMS risk is lower but income is also lower than the solution with 66 acres. Neither of these two solutions dominates the other. Thus, the utility function of the operator is needed to choose which of the these two farm plans he might implement.

Compared to the initial analysis income is lower and risk higher for the sensitivity analysis. However, neither of the two sensitivity analysis solutions dominates the other. Risk was \$386 lower as was income by \$1676 for the solution with 38 acres of EMS as compared to the solution with no EMS. Thus, if yields similar to these of the sensitivity analysis are expected, the utility function of the operator is needed to determine whether to produce EMS.

Risk and expected returns associated with the Target MOTAD model solutions may be seen graphically (Figure 4.1).

The solution of the initial analysis model that did not allow EMS is represented by the point A. The solution frontier of the initial analysis models that included EMS is represented by the line segment BC. Point B is the solution with 89 acres of EMS. Point C is the solution with 66 acres of EMS and the highest income of reported solutions. As mentioned earlier point C dominates point A, however it does not dominate B.

The solution frontier of the sensitivity analysis is represented by the line segment DE. The sensitivity analysis shows that results can be drastically affected by use of a weather distribution based on different ten years data. The graphical the relationship of risk and expected returns of the sensitivity analysis solutions of EMS indicates that a relatively small decrease in risk results in a large decrease in income.

One of the reasons results show inclusion of EMS in whole-farm plans is the soybeans sold in August have a price advantage. If large numbers of farmers shift from production of traditional soybeans to production of EMS, the price advantage for EMS would likely diminish or disappear. Moreover, research data available indicate lower seed quality for early maturing soybeans. This will not be a problem if small amounts of EMS are produced.

Hours of labor hired in the five Target MOTAD solutions range from nearly 225 to 180 (Table 4.2). The four weeks

Table 4.2 Labor Hiring Activities for Solutions from Target MOTAD
Models of a Representative Crop Farm in Southeastern Kansas.

Weeks ^a	Models Including EMS as an Alternative				
	Initial Analysis		Sensitivity Analysis		
	Model Without EMS	Solution with 89 A of EMS	Solution with 66 A of EMS	Solution with 38 A of EMS	Solution with 0 A of EMS
April W3	31.29	28.98	29.56	30.31	31.29
April W4	6.87	8.02	7.73	7.36	6.87
June W1	61.44	61.44	61.44	61.44	61.44
June W2	17.4	0	0.17	7.64	17.4
June W3	6.75	6.75	6.75	6.75	6.75
June W4	30.55	30.55	30.55	30.55	30.55
Oct. W2	11.19	0	0	4.85	11.19
Oct. W3	51.41	36.42	40.22	45.07	51.41
Oct. W5	7.88	7.88	7.88	7.88	7.88
Total Hours Hired	224.78	180.04	184.30	201.85	224.78

^a April W3 means the third week in April, etc.

with the most labor hired are the third week in April, first week in June, fourth week in June, and the third week in October. The field operations of seedbed preparation, planting, cultivating and harvest for EMS, traditional soybeans and grain sorghum, occur during one or more of these four weeks. Labor for traditional soybeans is required in five months, April, May and June for seedbed preparation and planting, July for row cultivating, and October for harvesting. EMS require labor in two months April for planting and August for harvest (Appendix C Table C46).

Incorporation of early-maturing soybeans into the representative southeastern Kansas crop farm reduces hired labor required during the cropping season. However, the total annual hours reduction of labor is small. The total annual difference between the initial ten-year period model in which 66 acres of EMS were produced and the model with no EMS was 40.48 hours. There was little difference in labor required during the critical planting times of spring crops. There were savings of about 11 hours per week during the second and third weeks in October. If the operator provides all the labor to the farm, these labor savings during October might be significant. The labor savings for the two weeks in October for the sensitivity analysis is about six hours per week.

On-farm resources totally used in the five Target MOTAD solutions of the representative crop farm in southeastern Kansas include cropland, wheat base acres, grain sorghum base acres, setaside acres and field work hours. Shadow prices for these resources are shown in Table 4.3. Shadow prices are valuations of resources by linear programming models. If the shadow price is positive then the interpretation is that forcing the model to include one more unit of that resource would reduce the income level by that shadow price. Conversely, if the shadow price is negative, allowing the model to have one more unit will increase income by that amount.

The shadow prices of cropland are all negative for the five solutions. The negative of the shadow price represents the amount the objective function would increase if the amount of the resource available were increased by one unit. In the initial analysis solution with 66 acres of EMS, the imputed value of one acre of land is \$145.32 per acre. Since the objective function is returns to fixed resources this imputed value includes other fixed resources in addition to land. This value is eighteen cents higher than the shadow price for the base model without EMS. Renting land at a value less than the shadow price would increase the objective function by the difference between the shadow price and the rent payment. As the risk measure is decreased the shadow price of land is increased. For

Table 4.3. Shadow Prices for Solutions of Target MOTAD Models for Land and Field-Work Hours for the Representative Crop Farm in Southeastern Kansas.^a

Resource	Models Including EMS as an Alternative				
	Initial Analysis			Sensitivity Analysis	
	Model Without EMS	Solution with 89 A of EMS	Solution with 66 A of EMS	Solution with 38 A of EMS	Solution with 0 A of EMS
Cropland	(\$145.14)	(\$168.15)	(\$145.32)	(\$184.58)	(\$142.74)
Wheat base	\$30.74	\$25.29	\$30.77	\$46.56	\$28.43
Milo base	\$42.89	\$61.77	\$43.07	(\$48.85)	\$40.49
Setaside	\$180.14	\$210.52	\$180.32	\$249.98	\$177.74
FWHAPRM3	(\$7.79)	(\$9.43)	(\$7.79)	(\$14.56)	(\$7.79)
FWHAPRM4	(\$7.79)	(\$9.43)	(\$7.79)	(\$14.56)	(\$7.79)
FWHJUNM1	(\$7.79)	(\$9.43)	(\$7.79)	(\$14.56)	(\$7.79)
FWHJUNM2	(\$7.79)	\$0.00	(\$7.79)	(\$14.56)	(\$7.79)
FWHJUNM3	(\$7.79)	(\$9.43)	(\$7.79)	(\$14.56)	(\$7.79)
FWHJUNM4	(\$7.79)	(\$9.43)	(\$7.79)	(\$14.56)	(\$7.79)
FWHOCTM2	(\$7.79)	\$0.00	(\$6.39)	(\$14.56)	(\$7.79)
FWHOCTM3	(\$7.79)	(\$9.43)	(\$7.79)	(\$14.56)	(\$7.79)
FWHOCTM5	(\$7.79)	(\$9.43)	(\$7.79)	(\$14.56)	(\$7.79)

^a A is an abbreviation for acres. The numbers in parenthesis are negative numbers. A negative shadow price indicates the amount the objective function would increase in one more unit of the resource were available. A positive shadow indicates the amount the objective function would decrease if the model were forced to use one more unit of the resource.

example, in the initial ten-year period the solution with 66 acres of EMS had a shadow price \$22.83 lower than the shadow price in the less risky solution with 89 acres of EMS. When the risk measure forces the model to increase EMS production beyond what it would if it did not have to consider risk, opportunities for increasing income by shifting acres from EMS to traditional soybeans are greater than in the solution when income is already at its maximum possible level. Therefore, the shadow price on cropland is greater when the risk measure forces a higher level of EMS production than the level that results in the highest income.

The shadow price for the wheat base acres, grain sorghum base acres, and setaside acres are all positive except for one. In the sensitivity analysis the grain sorghum shadow price was negative for the solution that included EMS. These positive shadow prices indicate that the soybean enterprises are more profitable when compared to the other cropping activities. If the operator were forced to increase his wheat base, grain sorghum base or setaside by one additional acre, the objective function would decrease by the amount of the shadow price. In the initial analysis solution including 66 acres of EMS, the addition of one acre of wheat base in production would decrease the objective function by \$30.77. In the sensitivity analysis solution, where grain sorghum had a negative value, one

additional acre of grain sorghum base would increase the objective function by \$48.85. The positive shadow prices indicate that the soybean producing activities, EMS and traditional soybeans, as modeled, are more profitable than the activities associated with government program participation. This may have occurred because of the high cost of setaside acres. Effort was taken to ensure that budgets for soybeans were comparable to budgets for wheat and grain sorghum. But, budgeting of soybean activities based on an experiment may have made them more efficient than the wheat and grain sorghum activities. Also based on the typical practice in southeastern Kansas all potash and phosphorous fertilizer was applied and charged to the wheat and grain sorghum crops.

The construction of the mathematical models of the representative crop farm in southeastern Kansas relates field-work hours to labor requirements and labor hiring activities. One hour of labor provides 0.77 field-work hours. That is, 1.3 hours of labor are required to provide one hour of field work time (Buller et al.) Thus, the shadow price of \$7.79 is the \$6.00 wage rate times 1.3. The shadow price of \$7.79 for field-work hours indicates that an additional hour of operator labor is valued at \$6, equal to the cost of hiring labor. Thus, the model equates the marginal value product (MVP) of labor and field-work hours to the marginal input cost (MIC) of labor and field-work

hours. This \$7.79 value occurs when labor is hired for the solutions that do not include EMS and the solution including 66 acres of EMS indicating that MVP equals MIC. However, in the first feasible solution of the initial and sensitivity analysis, the shadow prices on field-work hours are \$9.43 and \$14.56, respectively, both greater than \$7.79. The higher shadow prices occur because these two solutions can not reach equilibrium of MVP equal to MIC due to the risk measure constraint. Similar to the discussion of the shadow price on cropland, an additional hour of operator labor is more valuable when the risk measure forces the model to produce more acres of EMS than the acres that would provide the most income.

Income surpluses above the target income (positive numbers) and negative deviations from the target income (negative numbers) for the five solutions of the representative crop farm model are listed in Table 4.4. In eight of the ten years for all models at least the target income was attained. For the base model not including EMS, years two and nine had negative deviations from the target. For both solutions of the initial ten-year period including EMS, years two and three had negative deviations from the target. The sensitivity analysis ten-year period, where one solution included EMS and the other did not, had negative income deviations from the target income in years seven and nine for both solutions.

Table 4.4. Income Surpluses above and deficits below the Target Income of \$60,161 for Solutions of Target MOTAD Models of a Representative Crop Farm in Southeastern Kansas.^a

Years	Models Including EMS as an Alternative				
	Initial Analysis		Sensitivity Analysis		
	Model Without EMS	Solution with 89 A of EMS	Solution with 66 A of EMS	Solution with 38 A of EMS	Solution with 0 A of EMS
1	\$44,995	\$46,641	\$48,507	\$58,848	\$58,286
2	(\$6,734)	(\$2)	(\$1,665)	\$9,982	\$10,824
3	\$774	(\$3,598)	(\$2,455)	\$7,291	\$10,264
4	\$8,557	\$6,545	\$7,097	\$1,711	\$4,153
5	\$13,757	\$13,584	\$13,671	\$14	\$10,001
6	\$14,496	\$12,187	\$12,814	\$19,864	\$19,897
7	\$19,541	\$21,504	\$21,049	(\$9,457)	(\$10,439)
8	\$31,910	\$24,453	\$26,368	\$33,221	\$38,790
9	(\$1,026)	\$2,061	\$1,323	(\$14,513)	(\$17,391)
10	\$65,753	\$65,270	\$65,435	\$65,067	\$64,365

^a Positive numbers are the amount annual incomes exceeded the target. Negative numbers are the amount annual incomes fall below the target. EMS is an abbreviation for early-maturing soybeans. A is an abbreviation for acres.

In this study the Target MOTAD model did not account for two factors that affect the riskiness of this farm operation over time. First, years in which income was less than the target were all preceded by a year of high income. The surplus income above the target income, if put aside, would cover any of the negative deviations that followed. But the model does not account for usage of the preceding year's surplus to reduce the riskiness associated with low income years. Second, in initial analysis solutions that included EMS, two years in a row negative deviations occurred. Having two years with income less than the target back to back would generally imply greater risk to the farm operation than two bad years separated by years of surplus income. This greater risk is not accounted for by the model's construction.

With two of the ten years not attaining the target income, the models had trouble meeting the income goal only twenty percent of the time. Factors determining how many years the target will not be met are many. Three of the major factors are, size of the target income, amount of variability between years of farm operation, and overall profitability of cropping activities within a year. These results indicate that in most years the representative crop farm in southeastern Kansas as specified in this study

generates sufficient returns to meet the costs which make up the target income.

CHAPTER V

SUMMARY AND CONCLUSION

This study investigated the incorporation of early-maturing soybeans (EMS) into a representative crop farm in southeastern Kansas. Weather patterns of southeastern Kansas and seasonal price premiums may provide incentives to produce EMS.

Computer simulation models were used to generate weather and soybean yields for use in budgeting of the soybean enterprises. Weather simulation using WGEN (Richardson and Wright) provided for a continuous ninety-nine year data series. This generated weather data closely simulated actual weather observations. Yearly weather data from the simulation were incorporated into the crop simulation model, SOYGRO version 5.41 (Jones et al.), to generate ninety-nine years of simulated yield data for early-maturing soybeans and for traditional soybeans.

From the ninety-nine years of yield data, individual ten-year periods were analyzed as to mean, standard deviation, variance and number of years EMS out yielded traditional soybeans. An initial ten-year period that most closely represented the ninety-nine year parameters was chosen for economic analysis. A second ten-year period was

selected as not being favorable to EMS production and used for a sensitivity analysis.

For these two periods budgets were constructed to be representative of crop production practices from southeastern Kansas. Early-maturing soybeans, traditional soybeans, wheat and grain sorghum and a setaside activity were budgeted. Machinery costs and labor costs per acre were \$2.65 and \$2.75 less, respectively, for EMS than traditional soybeans. Seed costs were \$8.91 higher for EMS. Budgeted total variable costs were \$3.77 higher for EMS per acre than traditional soybeans. Average income above variable costs was \$47.11 higher for EMS and \$2.40 higher for traditional soybeans in the initial period as compared to the sensitivity analysis period.

Whole-farm Target MOTAD models of the initial and sensitivity analysis periods were used to examine risk and returns associated with including EMS in farm plans. In the initial analysis when the model did not allow production of EMS, income was \$79,366 and risk was \$776. A solution including 66 acres of EMS provided \$79,378 of income and risk of \$412. Thus, this solution was risk dominated over the solution with no EMS. The first feasible solution of the initial analysis reduced risk further but also lowered income.

The sensitivity analysis, based on a ten-year period unfavorable to EMS, provided a solution with no EMS production, income of \$78,862 and risk of \$2,783. The solution in the sensitivity analysis that included 38 acres of EMS reduced risk to \$2,397 but also lowered income to \$77,186.

EMS production reduced the amount of labor required during the production year by a maximum of forty hours. If the farm operator provides all the labor, labor savings of between six and eleven hours per week for two weeks in October may be significant.

It is concluded that inclusion of EMS in farm plans reduces risk. However, the reduction of risk comes with an increase or a decrease in income level depending on weather conditions and the amount of EMS acres planted. EMS also reduce labor requirements to the farm operator. Thus, reduction in risk and labor required during critical time periods provide incentives for diversification into EMS. The operators' preference for risk and returns and labor available in critical time periods will determine how many acres of EMS and traditional soybeans are planted.

Suggestions for Further Research

The following suggestions focus on how research on EMS may be improved and broadened. Improvement in the crop

simulation model to more accurately model Kansas conditions is suggested. Use of actual weather data for a long-term time period would improve this study and others like it over relying on simulated weather data. Use of actual results from agronomic studies would improve this study over use of simulated data. Economic analysis of EMS as to how this cropping activity may relate to Low Input Sustainable Agriculture (LISA) is warranted. LISA research may focus on rotational considerations of southeastern Kansas crop farms. Farm operators wanting to rotate land into fall or early spring planted and late spring harvested crops may find EMS economically beneficial over leaving land idle until fall planting may occur.

References

- Babaoglu, M. "Productivity of Short Season Soybean Cultivars in Kansas." M.S. thesis, Kansas State University, 1987.
- Barry, Peter J., John A. Hopkins and C.B. Baker., Financial Management in Agriculture. Danville, Illinois: The Interstate Printers & Publishers, Inc. 4th ed., 1988, pp.17-19.
- Beattie, Bruce R., and C. Robert Taylor. The Economics of Production. New York: John Wiley and Sons, 1985
- Boehlje, Michael D. and Vernon R. Eidman. Farm Management, New York: John Wiley and Sons, 1984, pp. 436-486.
- Buller, Orlan et al., Field Workdays in Kansas. KSU Agri. Exp. Stat. Bulletin 596, February 1976.
- Burton, Robert O. Jr., and Mario F. Chisostomo. "Potential Applications of Portfolio Theory to Research Focused on Farm Survival and Growth." Paper presented at Great Plains Committee Ten (Farm Management) Pingree Park, Colorado May 28-30, 1986.
- Cooperative Extension Service, KSU. Kansas Farm Management Association 1988 Records Report. 1989.
- Crisostomo, Mario F., et al. "A Target MOTAD Analysis of Double-Cropping and Alternative Cropping Patterns in Southeast Kansas." Staff Paper No. 88-9, Dept. of Ag. Econ., Kansas State University, January 1988.
- Doll, John P. and Frank Orazem. Production Economics Theory With Applications. New York: John Wiley and Sons, 1984, pp. 158-163 and 183-184.
- Figurski, Leo and John R. Schlender. Continuous Cropped Winter Wheat in Eastern Kansas. KSU Farm Management Guide MF-572. Revised August 1988.
- _____. Dryland Grain Sorghum in Eastern Kansas. KSU Farm Management Guide MF-573. Revised August 1988.

- Fuller, Earl I. and Mark F. McGuire. Minnesota Farm Machinery Economic Cost Estimates for 1988. Univ. of Minnesota, AG-FO-2308, Revised 1988.
- Granade, George V. "Early Maturing Soybeans in Southeastern Kansas." 1987 Agricultural Research Southeast Kansas Branch Station. Rep. of Prog. 517, Ag. Exp. Sta., Kansas State Univ. 1987, p. 101.
- _____. "Early Soybeans Compared with Full-Season Soybeans." 1988 Agricultural Research Southeast Kansas Branch Station. Rep. of Prog. 543, Ag. Exp. Sta., Kansas State Univ. 1988, p. 98.
- _____. "Early Soybeans Compared with Full-Season Soybeans." 1989 Agricultural Research Southeast Kansas Branch Station. Rep. of Prog. 571, Ag. Exp. Sta., Kansas State Univ. 1989, p. 75.
- Hartwig, Edgar E. "Varietal Development." Soybeans: Improvement, Production, and Uses. ed. B.E. Caldwell, American Society of Agronomy, 1973, pp. 187-188.
- Hazell, Peter B.R., and Roger D. Norton. Mathematical Programming for Economic Analysis in Agriculture. New York: Macmillan Publishing Co. 1986, pp. 117-120.
- Jones, J.W., et al. Soybean Growth Simulation Model, SOYGRO v5.41. Florida Ag. Exp. Sta. J. No. 8304, Feb. 1988.
- Kansas Agricultural Statistics. Kansas Farm Facts 1987. Topeka, KS: USDA KSBA, Aug. 1988a.
- _____. Kansas Farm Facts 1969-1987. Topeka, KS: USDA KSBA, Annual issues 1970-1988.
- _____. Kansas Grain Market and Transportation. Topeka, KS: USDA KSBA, December 1988b.
- _____. Crop-Weather. Weekly reports March through November, Topeka, KS USDA KSBA 1982-1988.
- Lee, Warren F., Michael D. Boehlje, Aaron G. Nelson, and William G. Murray. Agricultural Finance. 8th ed. Ames: The Iowa State University Press, 1988, pp. 32-40.
- Richardson, C. W. and D.A. Wright. WGEN: A Model for Generating Daily Weather Variables. USDA, ARS, August 1984.

- Ritchie, J.T. et al. "Model Inputs" in CERES-Maize A Simulation Model of Maize Growth and Development. College Station, Texas: Texas A&M University Press, 1986, pp. 37-44.
- Robison, Lindon, and Garth Carman. "Aggregate Risk Response Models and Market Equilibrium." In Risk Management in Agriculture: Behavioral, Managerial, and Policy Issues. Dept. Ag. Econ. AE-4478, Univ. of Illinois, 1979.
- Tauer, Loren W. "Target MOTAD." American Journal of Agricultural Economics. 65(1983):606-610.
- Thornton, Mace. "Area Farmers Harvest Agricultural Research." Kansas Farm Bureau News. May/June 1989, p. 13.
- U.S. Department of Agriculture. Agricultural Prices. Washington, D.C.: SRS, CRB, various Annual Summaries, 1970-1985.
- _____. Agricultural Prices. July and October. Average Monthly prices of wheat and grain sorghum, July and October, 1979-1988.
- _____. "Cash Bids from Country Elevators". Grain and Feed Market News. Second and Third weeks in August and the Third, Forth and Fifth weeks in October.
- _____. Soil Survey of Cherokee County Kansas, SCS 1985.
- _____. Soil Survey of Montgomery County Kansas. SCS 1980.
- _____. Soil Survey of Neosho County Kansas. SCS 1982.
- _____. Parsons Soil Series Description. SCS 1984.
- _____. Parsons Soil Primary Characterization Data. SCS 1987.
- U. S. Department of Commerce. Summary of Current Business. Annual Summary, "Prices Received by Farms Index" for 1988. January 1989.

van der Hoeven, Guido et al. "Comparison of Early Maturing and Full-Season Soybeans: An Economic Analysis." 1989 Agricultural Research. Report of Progress 571 Agri. Exp. Stat. KSU, 1989, pp. 77-81.

Vanderlip, Richard L. Personal Communications Spring and Summer 1989.

Watts, M.J., L.J. Held, and G.A. Helmers. "A Comparison of Target MOTAD to MOTAD." Canadian Journal of Agricultural Economics. Number 2(1984):1975-85.

Young, Douglas, William Lin, Rula Pope, Lindon Robison, and Roger Shelly. "Risk Preferences of Agricultural Producers: Their Management and Use." In Risk Management in Agriculture: Behavioral, Managerial, and Policy Issues. Dept. Ag. Econ. AE-4478 Univ. of Illinois, 1979.

APPENDIX A

MATRIX OF TARGET MOTAD MODEL

NAME EARLY MATURING SOYBEANS

ROWS

N OBFN
 L CROPLAND
 E WBASE
 E SORBASE
 E SETASIDE
 L FWHAPRW1
 L FWHAPRW2
 L FWHAPRW3
 L FWHAPRW4
 L FWHMAYW1
 L FWHMAYW2
 L FWHMAYW3
 L FWHMAYW4
 L FWHJUNW1
 L FWHJUNW2
 L FWHJUNW3
 L FWHJUNW4
 L FWHJUNW5
 L FWHJULW1
 L FWHJULW2
 L FWHJULW3
 L FWHJULW4
 L FWH AUGW1
 L FWH AUGW2
 L FWH AUGW3
 L FWH AUGW4
 L FWH AUGW5
 L FWHSEPW1
 L FWHSEPW2
 L FWHSEPW3
 L FWHSEPW4
 L FWH OCTW1
 L FWH OCTW2
 L FWH OCTW3
 L FWH OCTW4
 L FWH OCTW5
 G TXX01
 G TXX02
 G TXX03
 G TXX04
 G TXX05
 G TXX06
 G TXX07
 G TXX08
 G TXX09
 G TXX10
 L DEVIATIO

COLUMNS

EMS	OBJFN	146.96	CROPLAND	1.
EMS	FWHAPRW1	.11	FWHAPRW2	.11
EMS	FWHAPRW3	.11	FWHAPRW4	.10
EMS	FWHAUGW2	.13		
EMS	FWHAUGW3	.13	TXX01	117.96
EMS	TXX02	187.36	TXX03	33.00
EMS	TXX04	116.50	TXX05	223.69
EMS	TXX06	91.92	TXX07	161.97
EMS	TXX08	103.97	TXX09	216.43
EMS	TXX10	216.75		
FSB	OBJFN	150.44	CROPLAND	1.
FSB	FWHAPRW3	.13	FWHAPRW4	.09
FSB	FWHMAYW2	.11	FWHJUNW2	.20
FSB	FWHJUNW5	.07	FWHJULW1	.17
FSB	FWHOCTW2	.13	FWHOCTW3	.13
FSB	TXX01	68.66		
FSB	TXX02	114.57	TXX03	85.26
FSB	TXX04	142.18	TXX05	228.69
FSB	TXX06	120.95	TXX07	142.88
FSB	TXX08	191.21	TXX09	184.73
FSB	TXX10	225.21		
WHEAT	OBJFN	118.45	CROPLAND	1.
WHEAT	WBASE	1.	SETASIDE	.
WHEAT	FWHJUNW3	.15	FWHJUNW4	.15
WHEAT	FWHJULW3	.09	FWHAUGW3	.09
WHEAT	FWHSEPW2	.18	FWHOCTW2	.11
WHEAT	FWHOCTW3	.11		
WHEAT	TXX01	200.32	TXX02	141.76
WHEAT	TXX03	127.16	TXX04	111.51
WHEAT	TXX05	97.31	TXX06	159.16
WHEAT	TXX07	107.60	TXX08	87.10
WHEAT	TXX09	-45.09	TXX10	197.64
MILO	OBJFN	111.05	CROPLAND	1.
MILO	SORBASE	1.	SETASIDE	.
MILO	FWHAPRW3	.155	FWHAPRW4	.155
MILO	FWHMAYW3	.07	FWHMAYW4	.
MILO	FWHJUNW1	.39	FWHJUNW4	.17
MILO	FWHJULW2	.	FWHOCTW3	.13
MILO	FWHOCTW4	.13	FWHOCTW5	.13
MILO	TXX01	229.21	TXX02	-17.42
MILO	TXX03	74.34	TXX04	73.14
MILO	TXX05	23.48	TXX06	64.62
MILO	TXX07	135.69	TXX08	174.77
MILO	TXX09	183.98	TXX10	168.67
SETASIDE	OBJFN	-35.00	CROPLAND	1.
SETASIDE	SETASIDE	1.	TXX01	-35.00
SETASIDE	TXX02	-35.00	TXX03	-35.00
SETASIDE	TXX04	-35.00	TXX05	-35.00

SETASIDE	TXX06	-35.00	TXX07	-35.00
SETASIDE	TXX08	-35.00	TXX09	-35.00
SETASIDE	TXX10	-35.00		
APRW1	OBJFN	-6.	FWHAPRW1	-.77
APRW1	TXX01	-6.	TXX02	-6.
APRW1	TXX03	-6.	TXX04	-6.
APRW1	TXX05	-6.	TXX06	-6.
APRW1	TXX07	-6.	TXX08	-6.
APRW1	TXX09	-6.	TXX10	-6.
APRW2	OBJFN	-6.	FWHAPRW2	-.77
APRW2	TXX01	-6.	TXX02	-6.
APRW2	TXX03	-6.	TXX04	-6.
APRW2	TXX05	-6.	TXX06	-6.
APRW2	TXX07	-6.	TXX08	-6.
APRW2	TXX09	-6.	TXX10	-6.
APRW3	OBJFN	-6.	FWHAPRW3	-.77
APRW3	TXX01	-6.	TXX02	-6.
APRW3	TXX03	-6.	TXX04	-6.
APRW3	TXX05	-6.	TXX06	-6.
APRW3	TXX07	-6.	TXX08	-6.
APRW3	TXX09	-6.	TXX10	-6.
APRW4	OBJFN	-6.	FWHAPRW4	-.77
APRW4	TXX01	-6.	TXX02	-6.
APRW4	TXX03	-6.	TXX04	-6.
APRW4	TXX05	-6.	TXX06	-6.
APRW4	TXX07	-6.	TXX08	-6.
APRW4	TXX09	-6.	TXX10	-6.
MAYW1	OBJFN	-6.	FWHMAYW1	-.77
MAYW1	TXX01	-6.	TXX02	-6.
MAYW1	TXX03	-6.	TXX04	-6.
MAYW1	TXX05	-6.	TXX06	-6.
MAYW1	TXX07	-6.	TXX08	-6.
MAYW1	TXX09	-6.	TXX10	-6.
MAYW2	OBJFN	-6.	FWHMAYW2	-.77
MAYW2	TXX01	-6.	TXX02	-6.
MAYW2	TXX03	-6.	TXX04	-6.
MAYW2	TXX05	-6.	TXX06	-6.
MAYW2	TXX07	-6.	TXX08	-6.
MAYW2	TXX09	-6.	TXX10	-6.
MAYW3	OBJFN	-6.	FWHMAYW3	-.77
MAYW3	TXX01	-6.	TXX02	-6.
MAYW3	TXX03	-6.	TXX04	-6.
MAYW3	TXX05	-6.	TXX06	-6.
MAYW3	TXX07	-6.	TXX08	-6.
MAYW3	TXX09	-6.	TXX10	-6.
MAYW4	OBJFN	-6.	FWHMAYW4	-.77
MAYW4	TXX01	-6.	TXX02	-6.
MAYW4	TXX03	-6.	TXX04	-6.
MAYW4	TXX05	-6.	TXX06	-6.

MAYW4	TXX07	-6.	TXX08	-6.
MAYW4	TXX09	-6.	TXX10	-6.
JUNW1	OBJFN	-6.	FWHJUNW1	-.77
JUNW1	TXX01	-6.	TXX02	-6.
JUNW1	TXX03	-6.	TXX04	-6.
JUNW1	TXX05	-6.	TXX06	-6.
JUNW1	TXX07	-6.	TXX08	-6.
JUNW1	TXX09	-6.	TXX10	-6.
JUNW2	OBJFN	-6.	FWHJUNW2	-.77
JUNW2	TXX01	-6.	TXX02	-6.
JUNW2	TXX03	-6.	TXX04	-6.
JUNW2	TXX05	-6.	TXX06	-6.
JUNW2	TXX07	-6.	TXX08	-6.
JUNW2	TXX09	-6.	TXX10	-6.
JUNW3	OBJFN	-6.	FWHJUNW3	-.77
JUNW3	TXX01	-6.	TXX02	-6.
JUNW3	TXX03	-6.	TXX04	-6.
JUNW3	TXX05	-6.	TXX06	-6.
JUNW3	TXX07	-6.	TXX08	-6.
JUNW3	TXX09	-6.	TXX10	-6.
JUNW4	OBJFN	-6.	FWHJUNW4	-.77
JUNW4	TXX01	-6.	TXX02	-6.
JUNW4	TXX03	-6.	TXX04	-6.
JUNW4	TXX05	-6.	TXX06	-6.
JUNW4	TXX07	-6.	TXX08	-6.
JUNW4	TXX09	-6.	TXX10	-6.
JUNW5	OBJFN	-6.	FWHJUNW5	-.77
JUNW5	TXX01	-6.	TXX02	-6.
JUNW5	TXX03	-6.	TXX04	-6.
JUNW5	TXX05	-6.	TXX06	-6.
JUNW5	TXX07	-6.	TXX08	-6.
JUNW5	TXX09	-6.	TXX10	-6.
JULW1	OBJFN	-6.	FWHJULW1	-.77
JULW1	TXX01	-6.	TXX02	-6.
JULW1	TXX03	-6.	TXX04	-6.
JULW1	TXX05	-6.	TXX06	-6.
JULW1	TXX07	-6.	TXX08	-6.
JULW1	TXX09	-6.	TXX10	-6.
JULW2	OBJFN	-6.	FWHJULW2	-.77
JULW2	TXX01	-6.	TXX02	-6.
JULW2	TXX03	-6.	TXX04	-6.
JULW2	TXX05	-6.	TXX06	-6.
JULW2	TXX07	-6.	TXX08	-6.
JULW2	TXX09	-6.	TXX10	-6.
JULW3	OBJFN	-6.	FWHJULW3	-.77
JULW3	TXX01	-6.	TXX02	-6.
JULW3	TXX03	-6.	TXX04	-6.
JULW3	TXX05	-6.	TXX06	-6.
JULW3	TXX07	-6.	TXX08	-6.

JULW3	TXX09	-6.	TXX10	-6.
JULW4	OBJFN	-6.	FWHJULW4	-.77
JULW4	TXX01	-6.	TXX02	-6.
JULW4	TXX03	-6.	TXX04	-6.
JULW4	TXX05	-6.	TXX06	-6.
JULW4	TXX07	-6.	TXX08	-6.
JULW4	TXX09	-6.	TXX10	-6.
AUGW1	OBJFN	-6.	FWHAUGW1	-.77
AUGW1	TXX01	-6.	TXX02	-6.
AUGW1	TXX03	-6.	TXX04	-6.
AUGW1	TXX05	-6.	TXX06	-6.
AUGW1	TXX07	-6.	TXX08	-6.
AUGW1	TXX09	-6.	TXX10	-6.
AUGW2	OBJFN	-6.	FWHAUGW2	-.77
AUGW2	TXX01	-6.	TXX02	-6.
AUGW2	TXX03	-6.	TXX04	-6.
AUGW2	TXX05	-6.	TXX06	-6.
AUGW2	TXX07	-6.	TXX08	-6.
AUGW2	TXX09	-6.	TXX10	-6.
AUGW3	OBJFN	-6.	FWHAUGW3	-.77
AUGW3	TXX01	-6.	TXX02	-6.
AUGW3	TXX03	-6.	TXX04	-6.
AUGW3	TXX05	-6.	TXX06	-6.
AUGW3	TXX07	-6.	TXX08	-6.
AUGW3	TXX09	-6.	TXX10	-6.
AUGW4	OBJFN	-6.	FWHAUGW4	-.77
AUGW4	TXX01	-6.	TXX02	-6.
AUGW4	TXX03	-6.	TXX04	-6.
AUGW4	TXX05	-6.	TXX06	-6.
AUGW4	TXX07	-6.	TXX08	-6.
AUGW4	TXX09	-6.	TXX10	-6.
AUGW5	OBJFN	-6.	FWHAUGW5	-.77
AUGW5	TXX01	-6.	TXX02	-6.
AUGW5	TXX03	-6.	TXX04	-6.
AUGW5	TXX05	-6.	TXX06	-6.
AUGW5	TXX07	-6.	TXX08	-6.
AUGW5	TXX09	-6.	TXX10	-6.
SEPW1	OBJFN	-6.	FWHSEPW1	-.77
SEPW1	TXX01	-6.	TXX02	-6.
SEPW1	TXX03	-6.	TXX04	-6.
SEPW1	TXX05	-6.	TXX06	-6.
SEPW1	TXX07	-6.	TXX08	-6.
SEPW1	TXX09	-6.	TXX10	-6.
SEPW2	OBJFN	-6.	FWHSEPW2	-.77
SEPW2	TXX01	-6.	TXX02	-6.
SEPW2	TXX03	-6.	TXX04	-6.
SEPW2	TXX05	-6.	TXX06	-6.
SEPW2	TXX07	-6.	TXX08	-6.
SEPW2	TXX09	-6.	TXX10	-6.

SEPW3	OBJFN	-6.	FWHSEPW3	-.77
SEPW3	TXX01	-6.	TXX02	-6.
SEPW3	TXX03	-6.	TXX04	-6.
SEPW3	TXX05	-6.	TXX06	-6.
SEPW3	TXX07	-6.	TXX08	-6.
SEPW3	TXX09	-6.	TXX10	-6.
SEPW4	OBJFN	-6.	FWHSEPW4	-.77
SEPW4	TXX01	-6.	TXX02	-6.
SEPW4	TXX03	-6.	TXX04	-6.
SEPW4	TXX05	-6.	TXX06	-6.
SEPW4	TXX07	-6.	TXX08	-6.
SEPW4	TXX09	-6.	TXX10	-6.
OCTW1	OBJFN	-6.	FWHOCTW1	-.77
OCTW1	TXX01	-6.	TXX02	-6.
OCTW1	TXX03	-6.	TXX04	-6.
OCTW1	TXX05	-6.	TXX06	-6.
OCTW1	TXX07	-6.	TXX08	-6.
OCTW1	TXX09	-6.	TXX10	-6.
OCTW2	OBJFN	-6.	FWHOCTW2	-.77
OCTW2	TXX01	-6.	TXX02	-6.
OCTW2	TXX03	-6.	TXX04	-6.
OCTW2	TXX05	-6.	TXX06	-6.
OCTW2	TXX07	-6.	TXX08	-6.
OCTW2	TXX09	-6.	TXX10	-6.
OCTW3	OBJFN	-6.	FWHOCTW3	-.77
OCTW3	TXX01	-6.	TXX02	-6.
OCTW3	TXX03	-6.	TXX04	-6.
OCTW3	TXX05	-6.	TXX06	-6.
OCTW3	TXX07	-6.	TXX08	-6.
OCTW3	TXX09	-6.	TXX10	-6.
OCTW4	OBJFN	-6.	FWHOCTW4	-.77
OCTW4	TXX01	-6.	TXX02	-6.
OCTW4	TXX03	-6.	TXX04	-6.
OCTW4	TXX05	-6.	TXX06	-6.
OCTW4	TXX07	-6.	TXX08	-6.
OCTW4	TXX09	-6.	TXX10	-6.
OCTW5	OBJFN	-6.	FWHOCTW5	-.77
OCTW5	TXX01	-6.	TXX02	-6.
OCTW5	TXX03	-6.	TXX04	-6.
OCTW5	TXX05	-6.	TXX06	-6.
OCTW5	TXX07	-6.	TXX08	-6.
OCTW5	TXX09	-6.	TXX10	-6.
XX01	TXX01	1	DEVIATIO	.1
XX02	TXX02	1	DEVIATIO	.1
XX03	TXX03	1	DEVIATIO	.1
XX04	TXX04	1	DEVIATIO	.1
XX05	TXX05	1	DEVIATIO	.1
XX06	TXX06	1	DEVIATIO	.1
XX07	TXX07	1	DEVIATIO	.1

	XX08	TXX08	1	DEVIATIO	.1
	XX09	TXX09	1	DEVIATIO	.1
	XX10	TXX10	1	DEVIATIO	.1
RHS					
	RHS1	CROPLAND	700.	WBASE	252.
	RHS1	SORBASE	189	SETASIDE	49.
	RHS1	FWHAPRW1	16.7	FWHAPRW2	25.
	RHS1	FWHAPRW3	32.5	FWHAPRW4	42.9
	RHS1	FWHMAYW1	35.	FWHMAYW2	30.7
	RHS1	FWHMAYW3	39.3	FWHMAYW4	38.3
	RHS1	FWHJUNW1	26.4	FWHJUNW2	28.6
	RHS1	FWHJUNW3	32.6	FWHJUNW4	46.4
	RHS1	FWHJUNW5	50.	FWHJULW1	45
	RHS1	FWHJULW2	54.3	FWHJULW3	62.1
	RHS1	FWHJULW4	59.3	FWHAUGW1	67.
	RHS1	FWHAUGW2	60.	FWHAUGW3	50.7
	RHS1	FWHAUGW4	47.9	FWHAUGW5	27.8
	RHS1	FWHSEPW1	61.4	FWHSEPW2	61.4
	RHS1	FWHSEPW3	52.9	FWHSEPW4	48.6
	RHS1	FWHOCTW1	48.6	FWHOCTW2	46.4
	RHS1	FWHOCTW3	40.	FWHOCTW4	35.
	RHS1	FWHOCTW5	18.5	TXX01	60161.
	RHS1	TXX02	60161.	TXX03	60161.
	RHS1	TXX04	60161.	TXX05	60161.
	RHS1	TXX06	60161.	TXX07	60161.
	RHS1	TXX08	60161.	TXX09	60161.
	RHS1	TXX10	60161.	DEVIATIO	412.
ENDATA					

APPENDIX B

DEFINITIONS OF MATRIX TERMS

ROWS Rows are the constraint parameters in the model.

OBJFNP This is an abbreviation for the term objective function. One unit of an activity such as wheat production provides an amount equal to the income above variable costs. In the case of labor one unit requires the labor wage to be paid.

CROPLAND One unit of this resource allows for the production or setaside of crop activity in the representative crop farm.

WBASE This resource is the wheat base acres for the representative farm. Wheat may be planted to an amount equal to the base acres minus setaside since the farm participates in the government programs.

SORBASE This resource is the feedgrain base acres for the representative farm. Grain sorghum may be planted to an amount equal to base acres minus setaside since the farm participates in the government programs.

SETASIDE This resource represents the requirement, by farm program participation, to set land aside from crop production in the representative farm. One unit

(acre) is set aside for every ten acres of wheat and feedgrain base.

- FWHAPRW1 This resource abbreviation is for field work time available to the farm manager during the first week of April. A similar convention is used for the production months through October. One unit of this resource requires 1.3 hours of labor.
- TXX01 This row represents the annual income above variable costs in year one for the five land use activities and labor hiring activities. In the case of the four production enterprises the value is positive, for the setaside and hiring activities it is negative.
- DEVIATIO This row restricts the risk measure in dollars to specified levels.
- COLUMNS Columns are activities preformed within the model of the representative farm.
- EMS This activity provides one unit of early-maturing soybean production.
- FSB This activity provides one unit of traditional soybean production.
- WHEAT This activity provides one unit of wheat production.

MILO This activity provides one unit of grain sorghum production.

SETASIDE This activity provides for the necessary amount of land to be removed from production to comply with U.S. farm program requirements.

APRW1 This activity links field work hour constraints to labor hiring. A relationship of 1.3 hours of labor per one hour of field work time exists. The constraint is in hours, a conversion factor of 0.77 is used in the matrix to arrive at the value of hours of labor hired if any. One unit of this activity then will provide for 0.77 hours of field time in the first week of April. A similar convention is used for the thirty-one weeks of production, April through October.

XX01 This activity links the target income of \$60,161 to the generation of any negative deviation from the target in year one. A similar convention is used for the following nine years of the study.

RHS The values of the right-hand side give the values of the constraints as presented in the rows section.

APPENDIX C

CROP ENTERPRISE BUDGETS

SUPPORT TABLES

Notes Concerning Budgets:

Yields of early-maturing soybeans and traditional soybeans come from adjusted output from SOYGRO version 5.41. Yields of wheat and grain sorghum enterprises come from the latest crop performance tests as published by the Agricultural Experiment Station, KSU, 1979-1988.

Output prices of soybeans are based on the average weekly cash bids from Kansas City, Kansas country elevators for the week of predicted harvest as reported in Grain and Feed Market News by USDA. Output prices for wheat and grain sorghum are from Agricultural Prices as reported by USDA. These prices are the monthly average price for the harvest month.

Input requirements other than machinery costs for the soybean activities are from George Granade at the Southeast Kansas Branch Experiment Station. Input requirements for wheat come from Continuous Cropped Wheat in Eastern Kansas by Leo Figurski and John R. Schlender, MF-572, August 1988. Input requirements for grain sorghum come from Dryland Grain Sorghum in Eastern Kansas by Leo Figurski and John R. Schlender, MF-573, August 1988.

Machinery amounts and costs and labor amounts are from Tables 43 through 46 found in Appendix C.

Lime is applied every three to five years as needed, all lime is charged to budget in year applied.

Labor costs are from Forward Planning, KSU Farm Management Guide MF-525.

Government payments are calculated by subtracting the cash price from the target price then multiplying by the program yield in the wheat and grain sorghum budgets.

Table C1. Group One Soybean Budget planted April 25,
Persons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$6.32	31.30	\$197.82
Total receipts				\$197.82
2. Variable costs				
Seed	lbs.	\$0.16	87.27	\$13.96
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	2.00	\$20.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	0.91	\$5.46
Machinery cost				\$11.74
Misc. costs				\$8.42
Interest on 1/2 of variable cost	Dol.	\$0.12	37.67	\$4.52
Total Variable Cost				\$79.85
3. Income above variable cost				\$117.96

Table C2. Group One Soybean Budget planted April 25,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$6.93	35.50	\$246.02
Total receipts				\$246.02
2. Variable costs				
Seed	lbs.	\$0.16	87.27	\$13.96
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	0.91	\$5.46
Misc. costs				\$8.42
Machinery cost				\$11.74
Interest on 1/2 of variable cost	Dol.	\$0.12	27.67	\$3.32
Total Variable Cost				\$58.65
3. Income above variable cost				\$187.36

Table C3. Group One Soybean Budget planted April 25,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$6.11	15.00	\$91.65
Total receipts				\$91.65
2. Variable costs				
Seed	lbs.	\$0.16	87.27	\$13.96
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	0.91	\$5.46
Misc. costs				\$0.42
Machinery cost				\$11.74
Interest on 1/2 of variable cost	dol.	\$0.12	27.67	\$3.32
Total Variable Cost				\$58.65
3. Income above variable cost				\$33.00

Table C4. Group One Soybean Budget planted April 25,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$5.61	35.00	\$196.35
Total receipts				\$196.35
2. Variable costs				
Seed	lbs.	\$0.16	87.27	\$13.96
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	2.00	\$20.00
Herbicide				\$15.75
Insecticides				\$0.00
Labor	hr.	\$6.00	0.91	\$5.46
Misc. costs				\$8.42
Machinery cost				\$11.74
Interest on 1/2 of variable cost	Dol.	\$0.12	37.67	\$4.52
Total Variable Cost				\$79.85
3. Income above variable cost				\$116.50

Table C5. Group One Soybean Budget planted April 25,
Persons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$8.53	33.10	\$282.34
Total receipts				\$282.34
2. Variable costs				
Seed	lbs.	\$0.16	87.27	\$13.96
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	0.91	\$5.46
Misc. costs				\$8.42
Machinery cost				\$11.74
Interest on 1/2 of variable cost	Dol.	\$0.12	27.67	\$3.32
Total Variable Cost				\$58.65
3. Income above variable cost				\$223.69

Table C6. Group One Soybean Budget planted April 25,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$7.17	21.00	\$150.57
Total receipts				\$150.57
2. Variable costs				
Seed	lbs.	\$0.16	87.27	\$13.96
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	0.91	\$5.46
Misc. costs				\$8.42
Machinery cost				\$11.74
Interest on 1/2 of variable cost	Dol.	\$0.12	27.67	\$3.32
Total Variable Cost				\$58.65
3. Income above variable cost				\$91.92

Table C7. Group One Soybean Budget planted April 25,
Pereons, Kensee

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$6.25	35.30	\$220.63
Total receipts				\$220.63
2. Variable costs				
Seed	lbs.	\$0.16	87.27	\$13.96
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Lebor	hr.	\$6.00	0.91	\$5.46
Misc. costs				\$8.42
Machinery cost				\$11.74
Interest on 1/2 of variable cost	Dol.	\$0.12	27.67	\$3.32
Total Variable Cost				\$58.65
3. Income above variable cost				\$161.97

Table CB. Group One Soybean Budget planted April 25,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$8.17	22.50	\$183.83
Total receipts				\$183.83
2. Variable costs				
Seed	lbs.	\$0.16	87.27	\$13.96
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	2.00	\$20.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	0.91	\$5.46
Misc. costs				\$8.42
Machinery cost				\$11.74
Interest on 1/2 of variable cost	Gal.	\$0.12	37.67	\$4.52
Total Variable Cost				\$79.85
3. Income above variable cost				\$103.97

Table C9. Group One Soybean Budget planted April 25,
Persons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$8.02	34.30	\$275.09
Total receipts				\$275.09
2. Variable costs				
Seed	lbs.	\$0.16	87.27	\$13.96
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	0.91	\$5.46
Misc. costs				\$8.42
Machinery cost				\$11.74
Interest on 1/2 of variable cost	Dol.	\$0.12	27.67	\$3.32
Total Variable Cost				\$58.65
3. Income above variable cost				\$216.43

Table C10. Group One Soybean Budget planted April 25,
 Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$8.50	32.40	\$275.40
Total receipts				\$275.40
2. Variable costs				
Seed	lbs.	\$0.16	87.27	\$13.96
Phosphata	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	0.91	\$5.46
Misc. costs				\$8.42
Machinery cost				\$11.74
Interest on 1/2 of variable cost	dol.	\$0.12	27.67	\$3.32
Total Variable Cost				\$58.65
3. Income above variable cost				\$216.75

Table C11. Group Five Soybean Budget planted June 15,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$5.86	24.70	\$144.74
Total receipts				\$144.74
2. Variable costs				
Seed	lbs.	\$0.14	36.10	\$5.05
Phosphete	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	2.00	\$20.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	1.36	\$8.16
Misc. costs				\$8.42
Machinery cost				\$14.39
Interest on 1/2 of variable cost	Dol.	\$0.12	35.89	\$4.31
Total Variable Cost				\$76.08
3. Income above variable cost				\$68.66

Table C12. Group Five Soybean Budget planted June 15,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$7.09	23.90	\$169.45
Total receipts				\$169.45
2. Variable costs				
Seed	lbs.	\$0.14	36.10	\$5.05
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	1.36	\$8.16
Misc. costs				\$8.42
Machinery cost				\$14.39
Interest on 1/2 of variable cost	Dol.	\$0.12	25.89	\$3.11
Total Variable Cost				\$54.88
3. Income above variable cost				\$114.57

Table C13. Group Five Soybean Budget planted June 15,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$5.72	24.50	\$140.14
Total receipts				\$140.14
2. Variable costs				
Seed	lbs.	\$0.14	36.10	\$5.05
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	1.36	\$8.16
Misc. costs				\$8.42
Machinery cost				\$14.39
Interest on 1/2 of variable cost	Dol.	\$0.12	25.89	\$3.11
Total Variable Cost				\$54.88
3. Income above variable cost				\$85.26

Table C14. Group Five Soybean Budget planted June 15,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$5.52	35.70	\$197.06
Total receipts				\$197.06
2. Variable costs				
Seed	lbs.	\$0.14	36.10	\$5.05
Phosphete	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	1.36	\$8.16
Misc. costs				\$8.42
Machinery cost				\$14.39
Interest on 1/2 of variable cost	Dol.	\$0.12	25.89	\$3.11
Total Variable Cost				\$54.88
3. Income above variable cost				\$142.18

Table C15. Group Five Soybean Budget planted June 15,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$8.57	33.10	\$283.67
Total receipts				\$283.67
2. Variable costs				
Seed	lbs.	\$0.14	36.10	\$5.05
Phosphata	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	1.36	\$8.16
Misc. costs				\$8.42
Machinery cost				\$14.39
Interest on 1/2 of variable cost	Dol.	\$0.12	25.89	\$3.11
Total Variable Cost				\$54.88
3. Income above variable cost				\$228.79

Table C16. Group Five Soybean Budget planted June 15,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$6.95	25.30	\$175.84
Total receipts				\$175.84
2. Variable costs				
Seed	lbs.	\$0.14	36.10	\$5.05
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	1.36	\$8.16
Misc. costs				\$8.42
Machinery cost				\$14.39
Interest on 1/2 of variable cost	Doll.	\$0.12	25.89	\$3.11
Total Variable Cost				\$54.88
3. Income above variable cost				\$120.95

Table C17. Group Five Soybean Budget planted June 15,
Persons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$6.18	32.00	\$197.76
Total receipts				\$197.76
2. Variable costs				
Seed	lbs.	\$0.14	36.10	\$5.05
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	1.36	\$8.16
Misc. costs				\$8.42
Machinery cost				\$14.39
Interest on 1/2 of variable cost	Dol.	\$0.12	25.89	\$3.11
Total Variable Cost				\$54.88
3. Income above variable cost				\$142.88

Table C18. Group Five Soybean Budget planted June 15,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$7.99	30.80	\$246.09
Total receipts				\$246.09
2. Variable costs				
Seed	lbs.	\$0.14	36.10	\$5.05
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	1.36	\$8.16
Misc. costs				\$8.42
Machinery cost				\$14.39
Interest on 1/2 of variable cost	dol.	\$0.12	25.89	\$3.11
Total Variable Cost				\$54.88
3. Income above variable cost				\$191.21

Table C19. Group Five Soybean Budget planted June 15,
Persons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$7.35	32.60	\$239.61
Total receipts				\$239.61
2. Variable costs				
Seed	lbs.	\$0.14	36.10	\$5.05
Phosphates	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	1.36	\$8.16
Misc. costs				\$8.42
Machinery cost				\$14.39
Interest on 1/2 of variable cost	Doll.	\$0.12	25.89	\$3.11
Total Variable Cost				\$54.88
3. Income above variable cost				\$184.73

Table C20. Group Five Soybean Budget planted June 15,
 Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$7.89	35.50	\$280.10
Total receipts				\$280.10
2. Variable costs				
Seed	lbs.	\$0.14	36.10	\$5.05
Phosphate	lbs.	\$0.00	0.00	\$0.00
Potash	lbs.	\$0.00	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$15.75
Insecticide				\$0.00
Labor	hr.	\$6.00	1.36	\$8.16
Misc. costs				\$8.42
Machinery cost				\$14.39
Interest on 1/2 of variable cost	Dol.	\$0.12	25.89	\$3.11
Total Variable Cost				\$54.88
3. Income above variable cost				\$225.21

Table C21. Winter Wheat Budget planted October 15,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$3.43	71.00	\$243.53
Deficiency Payment if any		\$0.57	37.5	\$21.38
Total receipts				\$264.91
2. Variable costs				
Seed	lbs.	\$0.10	80.00	\$8.00
Nitrogen	lbs.	\$0.11	45.00	\$4.95
Phosphate	lbs.	\$0.26	25.00	\$6.50
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$8.65
Insecticide				\$0.00
Labor	hr.	\$6.00	1.13	\$6.78
Misc. costs				\$8.42
Machinery cost				\$16.43
Interest on 1/2 of variable cost	Dol.	\$0.12	30.47	\$3.66
Total Variable Cost				\$64.59
3. Income above variable cost				\$200.32

Table C22. Winter Wheat Budget planted October 15,
Persons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$3.22	55.00	\$177.10
Deficiency Payment if any		\$0.78	37.5	\$29.25
Total receipts				\$206.35
2. Variable costs				
Seed	lbs.	\$0.10	80.00	\$8.00
Nitrogen	lbs.	\$0.11	45.00	\$4.95
Phosphate	lbs.	\$0.26	25.00	\$6.50
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$8.65
Insecticide				\$0.00
Labor	hr.	\$6.00	1.13	\$6.78
Misc. costs				\$8.42
Machinery cost				\$16.43
Interest on 1/2 of variable cost	Dol.	\$0.12	30.47	\$3.66
Total Variable Cost				\$64.59
3. Income above variable cost				\$141.76

Table C23. Winter Wheat Budget planted October 15,
Persons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$3.34	50.00	\$167.00
Deficiency Payment if any		\$0.66	37.5	\$24.75
Total receipts				\$191.75
2. Variable costs				
Seed	lbs.	\$0.10	80.00	\$8.00
Nitrogen	lbs.	\$0.11	45.00	\$4.95
Phosphate	lbs.	\$0.26	25.00	\$6.50
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$8.65
Insecticide				\$0.00
Labor	hr.	\$6.00	1.13	\$6.78
Misc. costs				\$8.42
Machinery cost				\$16.43
Interest on 1/2 of variable cost	Dol.	\$0.12	30.47	\$3.66
Total Variable Cost				\$64.59
3. Income above variable cost				\$127.16

Tabla C24. Winter Wheat Budget planted October 15,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$3.48	45.00	\$156.60
Deficiency Payment if any		\$0.52	37.5	\$19.50
Total receipts				\$176.10
2. Variable costs				
Seed	lbs.	\$0.10	80.00	\$8.00
Nitrogen	lbs.	\$0.11	45.00	\$4.95
Phosphata	lbs.	\$0.26	25.00	\$6.50
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$8.65
Insecticide				\$0.00
Labor	hr.	\$6.00	1.13	\$6.78
Misc. costs				\$0.42
Machinery cost				\$16.43
Interest on 1/2 of variable cost	Dol.	\$0.12	30.47	\$3.66
Total Variable Cost				\$64.59
3. Income above variable cost				\$111.51

Tabla C25. Winter Wheat Budget planted October 15,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$3.40	41.00	\$139.40
Deficiency Payment if any		\$0.60	37.5	\$22.50
Total receipts				\$161.90
2. Variable costs				
Seed	lbs.	\$0.10	80.00	\$8.00
Nitrogen	lbs.	\$0.11	45.00	\$4.95
Phosphate	lbs.	\$0.26	25.00	\$6.50
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$8.65
Insecticide				\$0.00
Labor	hr.	\$6.00	1.13	\$6.78
Misc. costs				\$8.42
Machinery cost				\$16.43
Interest on 1/2 of variable cost	Dol.	\$0.12	30.47	\$3.66
Total Variable Cost				\$64.59
3. Income above variable cost				\$97.31

Table C26. Winter Wheat Budget planted October 15,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$3.43	59.00	\$202.37
Deficiency Payment if any		\$0.57	37.5	\$21.38
Total receipts				\$223.75
2. Variable costs				
Seed	lbs.	\$0.10	80.00	\$8.00
Nitrogen	lbs.	\$0.11	45.00	\$4.95
Phosphate	lbs.	\$0.26	25.00	\$6.50
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$8.65
Insecticide				\$0.00
Labor	hr.	\$6.00	1.13	\$6.78
Misc. costs				\$8.42
Machinery cost				\$16.43
Interest on 1/2 of variable cost	Dol.	\$0.12	30.47	\$3.66
Total Variable Cost				\$64.59
3. Income above variable cost				\$159.16

Table C27. Winter Wheat Budget planted October 15,
Persons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$2.61	46.00	\$120.06
Deficiency Payment if any		\$1.39	37.5	\$52.13
Total receipts				\$172.19
2. Variable costs				
Seed	lbs.	\$0.10	80.00	\$8.00
Nitrogen	lbs.	\$0.11	45.00	\$4.95
Phosphate	lbs.	\$0.26	25.00	\$6.50
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$8.65
Insecticide				\$0.00
Labor	hr.	\$6.00	1.13	\$6.78
Misc. costs				\$8.42
Machinery cost				\$16.43
Interest on 1/2 of variable cost	Dol.	\$0.12	30.47	\$3.66
Total Variable Cost				\$64.59
3. Income above variable cost				\$107.60

Table C28. Winter Wheat Budget planted October 15,
Persons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$3.38	38.00	\$128.44
Deficiency Payment if any		\$0.62	37.5	\$23.25
Total receipts				\$151.69
2. Variable costs				
Seed	lbs.	\$0.10	80.00	\$8.00
Nitrogen	lbs.	\$0.11	45.00	\$4.95
Phosphate	lbs.	\$0.26	25.00	\$6.50
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$8.65
Insecticide				\$0.00
Labor	hr.	\$6.00	1.13	\$6.78
Misc. costs				\$8.42
Machinery cost				\$16.43
Interest on 1/2 of variable cost	Dol.	\$0.12	30.47	\$3.66
Total Variable Cost				\$64.59
3. Income above variable cost				\$57.10

Table C29. Winter Wheat Budget planted October 15,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$3.48	0.00	\$0.00
Deficiency Payment if any		\$0.52	37.5	\$19.50
Total receipts				\$19.50
2. Variable costs				
Seed	lbs.	\$0.10	80.00	\$8.00
Nitrogen	lbs.	\$0.11	45.00	\$4.95
Phosphate	lbs.	\$0.26	25.00	\$6.50
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$8.65
Insecticide				\$0.00
Labor	hr.	\$6.00	1.13	\$6.78
Misc. costs				\$8.42
Machinery cost				\$16.43
Interest on 1/2 of variable cost	ool.	\$0.12	30.47	\$3.66
Total Variable Cost				\$64.59
3. Income above variable cost				(\$45.09)

Table C30. Winter wheat Budget planted October 15,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$3.35	71.00	\$237.85
Deficiency Payment if any		\$0.65	37.5	\$24.38
Total receipts				\$262.23
2. Variable costs				
Seed	lbs.	\$0.10	80.00	\$8.00
Nitrogen	lbs.	\$0.11	45.00	\$4.95
Phosphate	lbs.	\$0.26	25.00	\$6.50
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$8.65
Insecticide				\$0.00
Labor	hr.	\$6.00	1.13	\$6.78
Misc. costs				\$8.42
Machinery cost				\$16.43
Interest on 1/2 of variable cost	Gal.	\$0.12	30.47	\$3.66
Total Variable Cost				\$64.59
3. Income above variable cost				\$197.64

Table C31. Dryland Grain Sorghum Budget planted June 1,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$2.55	126.00	\$321.30
Deficiency Payment if any		\$0.15	53	\$7.95
Total receipts				\$329.25
2. Variable costs				
Seed	lbs.	\$0.75	5.50	\$4.13
Nitrogen	lbs.	\$0.11	80.00	\$8.80
Phosphate	lbs.	\$0.26	30.00	\$7.80
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$9.85
Insecticide				\$10.00
Drying	bu.	\$0.10	126	\$12.60
Labor	hr.	\$6.00	1.5	\$9.00
Misc. costs				\$8.42
Machinery cost				\$22.56
Interest on 1/2 of variable cost	Dol.	\$0.12	47.19	\$5.66
Total Variable Cost				\$100.04
3. Income above variable cost				\$229.21

Table C32. Dryland Grain Sorghum Budget planted June 1,
Persons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$2.77	26.00	\$72.02
Deficiency Payment if any		\$0.00	53	\$0.00
Total receipts				\$72.02
2. Variable costs				
Seed	lbs.	\$0.75	5.50	\$4.13
Nitrogen	lbs.	\$0.11	80.00	\$8.80
Phosphate	lbs.	\$0.26	30.00	\$7.80
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$9.85
Insecticide				\$10.00
Drying	bu.	\$0.10	26	\$2.60
Labor	hr.	\$6.00	1.5	\$9.00
Misc. costs				\$8.42
Machinery cost				\$22.58
Interest on 1/2 of variable cost	dol.	\$0.12	42.19	\$5.06
Total Variable Cost				\$89.44
3. Income above variable cost				(\$17.42)

Table C33. Dryland Grain Sorghum Budget planted June 1,
Persons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from	bu.	\$2.46	63.00	\$154.98
Production				
Deficiency Payment if any		\$0.24	53	\$12.72
Total receipts				\$167.70
2. Variable costs				
Seed	lbs.	\$0.75	5.50	\$4.13
Nitrogen	lbs.	\$0.11	80.00	\$8.80
Phosphete	lbs.	\$0.26	30.00	\$7.80
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$9.85
Insecticide				\$10.00
Drying	bu.	\$0.10	63	\$6.30
Labor	hr.	\$6.00	1.5	\$9.00
Misc. costs				\$8.42
Machinery cost				\$22.58
Interest on 1/2 of variable cost	0ol.	\$0.12	44.04	\$5.28
Total Variable Cost				\$93.36
3. Income above variable cost				\$74.34

Table C34. Dryland Grain Sorghum Budget planted June 1,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$2.34	63.00	\$147.42
Deficiency Payment if any		\$0.36	53	\$19.08
Total receipts				\$166.50
2. Variable costs				
Seed	lbs.	\$0.75	5.50	\$4.13
Nitrogen	lbs.	\$0.11	80.00	\$8.80
Phosphate	lbs.	\$0.26	30.00	\$7.80
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$9.85
Insecticide				\$10.00
Drying	bu.	\$0.10	63	\$6.30
Labor	hr.	\$6.00	1.5	\$9.00
Misc. costs				\$8.42
Machinery cost				\$22.56
Interest on 1/2 of variable cost	Dol.	\$0.12	44.04	\$5.28
Total Variable Cost				\$93.36
3. Income above variable cost				\$73.14

Table C35. Dryland Grain Sorghum Budget planted June 1,
Pereona, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$2.59	42.00	\$108.78
Deficiency Payment if any		\$0.11	53	\$5.83
Total receipts				\$114.61
2. Variable costs				
Seed	lbs.	\$0.75	5.50	\$4.13
Nitrogen	lbs.	\$0.11	80.00	\$8.80
Phosphate	lbs.	\$0.26	30.00	\$7.80
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$9.85
Insecticide				\$10.00
Drying	bu.	\$0.10	42	\$4.20
Labor	hr.	\$6.00	1.5	\$9.00
Misc. costs				\$8.42
Machinery cost				\$22.58
Interest on 1/2 of variable cost	Dol.	\$0.12	42.99	\$5.16
Total Variable Cost				\$91.13
3. Income above variable cost				\$23.48

Table C36. Dryland Grain Sorghum Budget planted June 1,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$2.41	59.00	\$142.19
Deficiency Payment if any		\$0.29	53	\$15.37
Total receipts				\$157.56
2. Variable costs				
Seed	lbs.	\$0.75	5.50	\$4.13
Nitrogen	lbs.	\$0.11	80.00	\$8.80
Phosphate	lbs.	\$0.26	30.00	\$7.80
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$9.85
Insecticide				\$10.00
Drying	bu.	\$0.10	59	\$5.90
Labor	hr.	\$6.00	1.5	\$9.00
Misc. costs				\$8.42
Machinery cost				\$22.58
Interest on 1/2 of variable cost	Dol.	\$0.12	43.84	\$5.26
Total Variable Cost				\$92.94
3. Income above variable cost				\$64.62

Table C37. Dryland Grain Sorghum Budget planted June 1,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$2.34	91.00	\$212.94
Deficiency Payment if any		\$0.36	53	\$19.08
Total receipts				\$232.02
2. Variable costs				
Seed	lbs.	\$0.75	5.50	\$4.13
Nitrogen	lbs.	\$0.11	80.00	\$8.80
Phosphate	lbs.	\$0.26	30.00	\$7.80
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$9.85
Insecticide				\$10.00
Drying	bu.	\$0.10	91	\$9.10
Labor	hr.	\$6.00	1.5	\$9.00
Misc. costs				\$8.42
Machinery cost				\$22.58
Interest on 1/2 of variable cost	Dol.	\$0.12	45.44	\$5.45
Total Variable Cost				\$96.33
3. Income above variable cost				\$135.69

Table C38. Dryland Grain Sorghum Budget planted June 1,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$2.36	108.00	\$254.88
Deficiency Payment if any		\$0.34	53	\$18.02
Total receipts				\$272.90
2. Variable costs				
Seed	lbs.	\$0.75	5.50	\$4.13
Nitrogen	lbs.	\$0.11	80.00	\$8.80
Phosphate	lbs.	\$0.26	30.00	\$7.80
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$9.85
Insecticide				\$10.00
Drying	bu.	\$0.10	108	\$10.80
Labor	hr.	\$6.00	1.5	\$9.00
Misc. costs				\$8.42
Machinery cost				\$22.58
Interest on 1/2 of variable cost	dol.	\$0.12	46.29	\$5.55
Total Variable Cost				\$98.13
3. Income above variable cost				\$174.77

Table C39. Dryland Grain Sorghum Budget planted June 1,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$2.22	116.00	\$257.52
Deficiency Payment if any		\$0.48	53	\$25.44
Total receipts				\$282.96
2. Variable costs				
Seed	lbs.	\$0.75	5.50	\$4.13
Nitrogen	lbs.	\$0.11	80.00	\$8.80
Phosphate	lbs.	\$0.26	30.00	\$7.80
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$9.85
Insecticide				\$10.00
Drying	bu.	\$0.10	116	\$11.60
Labor	hr.	\$6.00	1.5	\$9.00
Misc. costs				\$8.42
Machinery cost				\$22.58
Interest on 1/2 of variable cost	bol.	\$0.12	46.69	\$5.60
Total Variable Cost				\$98.98
3. Income above variable cost				\$183.98

Table C40. Dryland Grain Sorghum Budget planted June 1,
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$2.33	106.00	\$246.98
Deficiency Payment if any		\$0.37	53	\$19.61
Total receipts				\$266.59
2. Variable costs				
Seed	lbs.	\$0.75	5.50	\$4.13
Nitrogen	lbs.	\$0.11	80.00	\$8.80
Phosphate	lbs.	\$0.26	30.00	\$7.80
Potash	lbs.	\$0.12	10.00	\$1.20
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$9.85
Insecticide				\$10.00
Drying	bu.	\$0.10	106	\$10.60
Labor	hr.	\$6.00	1.5	\$9.00
Misc. costs				\$8.42
Machinery cost				\$22.58
Interest on 1/2 of variable cost	Dol.	\$0.12	46.19	\$5.54
Total Variable Cost				\$97.92
3. Income above variable cost				\$168.67

Table C41. Setaside Red Clover Budget planted in March.
Parsons, Kansas

	Unit	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	bu.	\$0.00	0.00	\$0.00
Deficiency Payment if any		\$0.00	0	\$0.00
Total receipts				\$0.00
2. Variable costs				
Seed	lbs.	\$2.00	8.00	\$16.00
Nitrogen	lbs.	\$0.11	0.00	\$0.00
Phosphete	lbs.	\$0.26	0.00	\$0.00
Potash	lbs.	\$0.12	0.00	\$0.00
Lime	ton	\$10.00	0.00	\$0.00
Herbicide				\$0.00
Insecticide				\$0.00
Drying	bu.	\$0.10	0	\$0.00
Labor	hr.	\$6.00	0.505	\$3.03
Misc. costs				\$8.42
Machinery cost				\$5.57
Interest on 1/2 of variable cost	Dol.	\$0.12	16.51	\$1.98
Total Variable Cost				\$35.00
3. Income above variable cost				(\$35.00)

Table C42. Early Maturing Soybeans, Machinery and Labor Requirements for Parsons, Kansas, April Planting 1968.^a

Machinery Operation ^b	Month	Size	Machinery #r/A Machinery Cost				Labor Hours/Acre	
			Times Over	One Time Over	This Budget	This Budget	This Budget	Labor Cost
Field Cultivat.	April	18 ft	3	0.11	0.34	\$3.93	0.45	\$2.68
Herb. Sprayer	April	18 ft	1	0.11	0.11	\$0.43	0.15	\$0.89
Plant (drill)	April	24 ft	1	0.10	0.10	\$1.74	0.14	\$0.82
April Total	.	.	.	.	0.56	\$6.10	0.73	\$4.39
Combine soy	August	Large	1	0.20	0.20	\$5.92	0.26	\$1.57
Medium truck	August	400 bu	1	0.06	0.06	\$0.56	0.08	\$0.48
August Total	.	.	.	.	0.26	\$6.48	0.34	\$2.05
Annual Total	.	.	.	.	0.83	\$12.58	1.07	\$6.44

^a Machinery hours are based on acres per hour reported in Doanes Agricultural Report, 3-27-67. Machinery cost per acre come from Table C48. Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.W., O.W. Buller, and J.C. Kasper. Labor Requirements for Eastern Kansas Crops. Kansas Agr. Exp. Sta. Bul. 587, June 1975.

^b Tillage operations were obtained from George Granade and are actual operations performed at the Southeast Kansas Branch Experiment Station.

Table C43. Full Season Soybeans, Machinery and Labor Requirements for
Parsons, Kansas, June Planting 1988.^a

Machinery Operation ^b	Month	Size	Machinery Hr/A Machinery Cost				Labor Hours/Acre	
			Times Over	One Time Over	This Budget	This Budget	This Budget	Labor Cost
Field Cultivat.	April	18 ft	3	0.11	0.34	\$3.93	0.45	\$2.68
Harb. Sprayer	April	18 ft	1	0.11	0.11	\$0.43	0.15	\$0.89
April Total	.	.	.	.	0.46	\$4.36	0.60	\$3.57
Planter (row)	June	6-30	1	0.20	0.20	\$2.73	0.26	\$1.59
June Total	.	.	.	.	0.20	\$2.73	0.26	\$1.59
Row Cultivat.	July	6-30	1	0.17	0.17	\$1.23	0.22	\$1.34
July Total	.	.	.	.	0.17	\$1.23	0.22	\$1.34
Combine soy	October	Large	1	0.20	0.20	\$5.92	0.26	\$1.57
Medium truck	October	400 bu	1	0.06	0.06	\$0.56	0.08	\$0.48
October Total	.	.	.	.	0.26	\$6.48	0.34	\$2.05
Annual Total	.	.	.	.	1.10	\$14.80	1.43	\$8.55

^a Machinery hours are based on acres per hour reported in Doanes Agricultural Report, 3-27-87. Machinery cost per acre come from Table 48. Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.W., O.W. Bullar, and J.C. Kasper. Labor Requirements for Eastern Kansas Crops. Kansas Agr. Exp. Sta. Bul. 587, June 1975.

^b Tillage operations were obtained from George Granada and are actual operations performed at the Southeast Kansas Branch Experiment Station.

Table C44. Full-Season Grain Sorghum, Machinery and Labor Requirements for Persons, Kansas, June Planting.^a

Machinery Operation ^b	Month	Size	Machinery Hr/A Machinery Cost				Labor Hours/Acre	
			Times Over	One Time Over	This Budget	This Budget	This Budget	Labor Cost
Chisel Plow	April	17 ft	1	0.13	0.13	\$1.84	0.18	\$1.05
Disk (Tendern)	April	24 ft	2	0.09	0.17	\$2.50	0.22	\$1.34
April Total					0.31	\$4.34	0.40	\$2.39
Fertilizer (dry)	May		1	0.07	0.07	\$3.19	0.09	\$0.52
Herb. Sprayer	May	30 ft	1	0.07	0.07	\$0.43	0.09	\$0.55
Field Cultivat.	May	18 ft	1	0.11	0.11	\$1.31	0.15	\$0.89
May Total					0.25	\$4.93	0.33	\$1.96
Planter (row)	June	6-30	1	0.20	0.20	\$2.73	0.26	\$1.59
Row Cultivat.	June	6-30	1	0.17	0.17	\$1.23	0.22	\$1.34
June Total					0.38	\$3.96	0.49	\$2.93
Row Cultivat.	July	6-30	1	0.17	0.17	\$1.23	0.22	\$1.34
July Total					0.17	\$1.23	0.22	\$1.34
Combine wheat	October	Large	1	0.16	0.16	\$5.92	0.21	\$1.24
Medium truck	October	400 bu	1	0.23	0.23	\$4.66	0.30	\$1.81
October Total					0.39	\$10.58	0.51	\$3.04
Annual Total					1.11	\$14.46	1.44	\$8.62

^a Machinery hours are based on acres per hour reported in Doanes Agricultural Report, 3-27-67.

Machinery cost per acre come from Table 48. Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper. Labor Requirements for Eastern Kansas Crops. Kansas Agr. Exp. Sta. Bul. 587, June 1975.

^b Tillage operations were constructed as those typical of Southeastern Kansas grain sorghum production.

Table C45. Winter Wheat, Machinery and Labor Requirements for
Parsons, Kansas, October Planting.^a

Machinery Operation ^b	Month	Size	Machinery Hr/A Machinery Cost				Labor Hours/Acre	
			Times Over	One Time Over	This Budget	This Budget	This Budget	Labor Cost
Disk (Tandem)	Sept.	24 ft	2	0.09	0.17	\$2.50	0.22	\$1.34
Field Cultivat.	Sept.	18 ft	1	0.11	0.11	\$1.31	0.15	\$0.89
September Total	.	.	.	.	0.29	\$3.81	0.37	\$2.23
Fertilizer (dry)	October		1	0.07	0.07	\$3.19	0.09	\$0.52
Field Cultivat.	October	18 ft	1	0.11	0.11	\$1.31	0.15	\$0.89
Plant (drill)	October	24 ft	1	0.10	0.10	\$1.74	0.14	\$0.82
October Total	.	.	.	.	0.29	\$6.24	0.37	\$2.23
Combine wheat	June	Large	1	0.16	0.16	\$4.66	0.21	\$1.24
Medium truck	June	400 bu	1	0.14	0.14	\$1.72	0.18	\$1.09
June Total	.	.	.	.	0.30	\$6.38	0.39	\$2.33
Annual Total	.	.	.	.	0.87	\$16.43	1.13	\$6.80

^a Machinery hours are based on acres per hour reported in Osages Agricultural Report, 3-27-87. Machinery cost per acre come from Table 25e. Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.M., D.H. Buller, and J.C. Kasper. Labor Requirements for Eastern Kansas Crops. Kansas Agr. Exp. Sta. Bul. 587, June 1975.

^b Tillage operations were constructed as those typical of Southeastern Kansas winter wheat production.

Table C 46. Machinery Operation Timing for the Representative Southeastern Kansas Crop Farm.

APRIL				
<u>Week</u>	<u>EMS</u>	<u>TS</u>	<u>Wheat</u>	<u>Grain Sorghum</u>
1	Chisel & Disk			
2	Field Cult & Herbicide			
3		Chisel plow		Chisel plow
4	Plant (drill)	Disk		Disk
MAY				
1				
2		Field Cult & Herbicide		
3				Fertilize
4				
JUNE				
1				Field cult. & Herbicide & Plant
2		Plant		
3			Harvest	Row cult.
4			Harvest	
5				
JULY				
1		Row cult.		
2				
3			Disk	
4				
AUGUST				
1	Harvest			
2	Harvest			
3			Disk	
4				
SEPTEMBER				
1				
2				
3			Fertilize & Field cult.	
4				
OCTOBER				
1				
2		Harvest	Field cult.	
3		Harvest	Plant	Harvest
4				Harvest
5				Harvest

Table C47. Days Suitable for Fieldwork in Southeast Kansas.

Week	Years							Average
	1982	1983	1984	1985	1986	1987	1988	
1st wk of March							5.3	5.30
2nd wk of March						4.0	0.5	2.25
3rd wk of March						2.0		2.00
4th wk of March						0.5	1.0	0.75
1st wk of April					2.0	1.5	1.5	1.67
2nd wk of April					1.5	5.0	1.0	2.50
3rd wk of April	6.5				3.0	1.0	2.5	3.25
4th wk of April	7.0	1.5	2.5	5.5	6.0	5.0	2.5	4.29
1st wk of May	4.0	1.5	1.5	1.0	5.0	6.5	5.0	3.50
2nd wk of May	3.5	2.0	3.5	1.0	5.5	1.5	4.5	3.07
3rd wk of May	3.5	3.0	4.0	2.0	3.0	5.0	7.0	3.93
4th wk of May	0.0	1.5	6.5	4.5	2.0	6.0	6.5	3.86
1st wk of June	0.5	2.0	4.0	3.0	3.5	1.0	4.5	2.64
2nd wk of June	0.0	3.0	5.0	0.0	3.0	3.0	6.0	2.86
3rd wk of June	0.5	4.0	3.5	1.5	2.0	4.5	7.0	3.29
4th wk of June	1.0	4.5	3.5	4.0	6.5	6.5	6.5	4.64
5th wk of June	3.5	6.5	4.0	4.0	6.0	4.0	7.0	5.00
1st wk of July	4.0	2.0	6.0	6.5	4.0	3.5	5.5	4.50
2nd wk of July	6.0	4.0	6.5	7.0	5.0	4.0	5.5	5.43
3rd wk of July	5.5	7.0	6.5	7.0	6.0	6.0	5.5	6.21
4th wk of July	6.5	6.0	7.0	5.5	7.0	7.0	2.5	5.93
1st wk of Aug.	6.5	7.0	7.0	6.5	7.0	7.0	6.0	6.71
2nd wk of Aug.	7.0	6.5	7.0	4.0	4.5	6.0	7.0	6.00
3rd wk of Aug.	4.5	6.5	7.0	2.0	5.0	4.5	6.0	5.07
4th wk of Aug.	3.5	7.0	6.5	1.0	5.0	4.0	6.5	4.79
5th wk of Aug.	6.0	7.0				1.0	5.5	4.88
1st wk of Sept.	7.0	6.5	6.5	4.5	5.0	6.5	7.0	6.14
2nd wk of Sept.	7.0	6.5	6.5	7.0	4.5	4.5	7.0	6.14
3rd wk of Sept.	4.0	5.5	6.5	5.5	4.5	5.0	6.0	5.29
4th wk of Sept.	6.5	4.0	7.0	5.0	1.5	5.5	4.5	4.86
1st wk of Oct.	7.0	6.5	6.5	1.0	5.0	3.5	4.5	4.86
2nd wk of Oct.	6.0	6.0	6.5	2.5	0.5	7.0	4.0	4.64
3rd wk of Oct.	6.0	2.0	5.0	3.5	1.0	5.0	5.5	4.00
4th wk of Oct.	6.5	1.0	2.0	1.5	2.5	5.0	6.0	3.50
5th wk of Oct.		2.0	2.0	3.5			5.5	3.25
1st wk of Nov.	6.0	1.5	1.0	3.5	3.0	4.5	7.0	3.79
2nd wk of Nov.	6.0	1.5	5.0	6.0	1.5	6.5		4.42
3rd wk of Nov.	5.5	3.0	6.5	1.0	2.0	6.5	2.5	3.86
4th wk of Nov.	5.5	2.0	2.0	1.0	4.5	1.5	2.5	2.71
5th wk of Nov.	4.0		3.0	0.0	3.0	1.0		2.20

Fieldwork Days per week are from CROP-WEATHER reports published each week during the cropping season (March - November) for the years 1982 - 1988 by Kansas Agricultural Statistics.

Southeast Kansas crop reporting district is the 14 counties in the S.E. corner.

Table C48. Machinery Complement and associated fuel, repair and lubrication costs for 1985.

Equipment	Size (ft or hp)	Life (hrs)	Repair ret1	Factors ret2	New Cost \$/acre/hr	Fuel gal/hr	HP req'd machine	Fuel cost/ fuel cost per gal	Oil & Lube	Repair \$/acre	Tractor Repair \$/acre	Total Repair & Fuel/lube
tractor 1	140	10000	0.01	2	\$45,636	8.4	140	\$0.00	per hour	\$4.56		\$4.56
tractor 2	75	10000	0.01	2	\$23,519	4.5	75	\$0.00	per hour	\$2.35		\$2.35
Chisel plow	17	2000	0.20	1.4	\$3,390	7.42	8.4	140	\$0.00	\$0.01	\$0.43	\$1.84
Field Cultivator	18	2000	0.3	1.4	\$4,000	8.73	6	100	\$0.00	\$0.25	\$0.05	\$1.21
Fert. (tractor)	10000		0.01	2	\$45,636	15	6.6	110	\$0.00	\$0.25	\$0.04	\$0.69
Moldboard plow	6-16	2000	0.43	1.9	\$962	3.49	7.2	120	\$0.00	\$1.65	\$0.17	\$4.06
Tandem disk	36	2000	0.18	1.7	\$12,485	11.64	7.2	120	\$0.00	\$0.09	\$0.05	\$1.15
Planter	6-30	1200	0.54	2.1	\$11,971	4.91	3.4	60	\$0.00	\$0.59	\$0.06	\$2.73
Grain Drill	24	1200	0.54	2.1	\$15,403	9.56	4.5	75	\$0.00	\$0.50	\$0.06	\$1.74
Cultivator	6-30	2000	0.22	2.2	\$3,173	5.81	3.4	60	\$0.00	\$0.49	\$0.05	\$1.23
Sprayer	30	1500	0.41	1.3	\$3,430	14.16	2.4	40	\$0.00	\$0.14	\$0.01	\$0.43
Combine-sorghum	large	2000	0.12	2.1	\$84,125	4.96	8.7	145	\$0.00	\$1.40	\$0.14	\$5.91
Combine-wheat	large	2000	0.12	2.1	\$84,125	6.3	8.7	145	\$0.00	\$1.10	\$0.11	\$4.66
Median Truck-bean	400 bu	2000	0.01	2	\$18,450	21.9	13.5	225	\$0.00	\$0.49	\$0.05	\$0.56
Median Truck-wheat	400 bu	2000	0.01	2	\$18,450	7.12	13.5	225	\$0.00	\$1.51	\$0.15	\$1.72
Median Truck-alfalfa	400 bu	2000	0.01	2	\$18,450	4.32	13.5	225	\$0.00	\$1.50	\$0.25	\$2.86
Light Truck	pickup	3000	0.01	2	\$4,200	3.5	5.46	91	\$0.00	\$1.25	\$0.12	\$1.44

Repair cost/acre = (Last price * ret * ((life/1000)*ret2)/life)/acre/hr

Total Cost per acre is summation of fuel, lubrication, implement repair per acre and tractor repair per acre.

Formulas and Repair Factors from Metz, C.A., "A Standard Model for Repair Costs."

American Society of Agricultural Engineers paper No. 95-1527, December 1985

Machinery cost, cost, fuel usage, fuel cost, acre/hr from Fuller, Earl J. and Mark F. McGuire, Minnesota Farm Machinery

Resource Cost Estimates for 1984, AG-PC-1308, Revised 1988, Minnesota Extension Service

Fuel per hour = .86 * hp required

Lubrication cost are calculated to be ten percent of fuel costs.

Fuel per acre is calculated by dividing gallons per hour by acres per hour multiplied by price per gallon.

Repair constants for median truck and light truck are assumed to be the same as for tractors.

Price for light truck is an average of used and new prices.

Yield for 1989 is assumed to be 18.25 bushels/acre for soybeans, 35.45 for wheat, 92.5 for alfalfa so the median truck is utilized

for varying acreages proportionate to crop yield.

Formulas are by computer and rounding in columns may give incorrect calculation loophead.

INCORPORATION OF EARLY-MATURING SOYBEANS INTO A
REPRESENTATIVE SOUTHEASTERN KANSAS CROP FARM:
AN ECONOMIC ANALYSIS USING TARGET MOTAD

by

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ABSTRACT

The objective of this study is to investigate the impacts of incorporating early-maturing soybeans into a representative southeastern Kansas crop farm. Target MOTAD mathematical programming is used in conjunction with weather and crop simulation.

Whole-farm plans were developed for two ten-year periods, an initial period where the simulated yields of early-maturing soybeans were most like the ninety-nine years simulated and a sensitivity analysis period unfavorable to production of early-maturing soybeans. Land use activities included early-maturing soybeans, traditional soybeans, wheat, grain sorghum and setaside.

Thus, the model focuses on selection of the number of acres of EMS and traditional soybeans when returns are maximized subject to given levels of risk. The representative farm operator participates in the 1989 government program; so wheat, grain sorghum acreage and setaside is considered fixed. Seasonal labor may be hired.

It is concluded that inclusion of early-maturing soybeans in farm plans reduce risk. However, the reduction of risk comes with an increase or a decrease in income level depending on weather conditions and the amount of early-maturing soybean acres planted. Early-maturing soybeans also reduce labor requirements to the farm operator. Thus, reduction in risk and labor required during critical time periods provide incentives for diversification into EMS. On individual farms, the operators' preference for risk and

returns and labor available in critical time periods will determine how many acres of early-maturing soybeans and traditional soybeans are planted.